The Woodland Booke

Done at ye house in the Woode
at Capnptosorus, 1893–1932.

Marvel Cave Ozarks
Violets of the Ozarks
Little People of the Rocks
The "Frost Lily"
Ferns of the Ozarks and otherwheres
"Marvel Cave" the Great Cavern
Fairies of the Fern
Fairies of the Waterfalls
Fairies of the Woods
Wild Flowers

The Woodland Booke

In 1893 a very sick man was taken out of a great city by his friends, and left on one of the Ozark hills to shift for himself; I procedded to <shift> and recovery was rapid.

From the very first I loved those hills and ravines – the forests, and rocks, and streams; and realized that here was the spot that appealed to every sense of my being

To merely say that I 'located a homestead' ~~on~~ among the giant white-oaks in the midst of this beautiful country, gives but little idea of the joyous seeking – of the glorious days of adventuring over the great hills and thru the beautiful glens – the weeks of happiness in the wonderful forest – and the pure sweet air.

At last it was found – just the right-spot – and there I spent the happiest ten years of my life. It was a very quiet life; neighbors few and far away. I truly lived 'next to nature'. I saw the wonderful quail-dance, and their love-making. A great patch of huckleberries were reserved for them alone; turkey and quail came at the summons of the rat-a-tat on a pan for a special feed. A long-billed marsh wren built her nest and reared her brood every year in a bush very near my 'shack', nor seemed to care when I approached the nest. I never saw <u>him</u> – perhaps he thought that I ought to work too. A white-breasted nut-hatch would pick up pieces of gay-colored yarn from the table where I was writing

and how she would scold if I moved! A fat old ground hog would stop and look in the door on his way to the garden for the muskmelon which I, as well as he knew was calling to be eaten. Which one of us ate it? The one who got there first: that was the game! And such melons! Never were finer than grew in that gravel.

I had neither dog, gun nor cat; it was very quiet. Deer would come to feed on the barley and rye which I planted for them. They grew quite unafraid — seemed to know there was safety within my fences.

This home spot became the center of an area where many ferns grew in the greatest luxuriance and gave me the opportunity to study these, my favorite plants, intensively. I named the spot 'Camptosorus' after one of them — one of the most common.

The ferns were not, however, the only things I studied. There were the trees and flowers; rocks; waters; caves. The growth of plants; agriculture. A classic might be written on the production of an ear of corn — or of a sweet potato! I studied the hoe, and fed myself royally; and entertained my neighbors! I shall never forget the thrill of pride which I felt when I gathered my first crop of corn. I could not wait to take it to mill — half a day over the mountain! — but beat it with a hammer — never was finer tasted bread!

How I loved them all — the mountains and

and valleys – the forest and its sounds and music – even my little garden! Not until I had to leave them did I know how deeply they had become a part of my life – how passionately I loved them all! Never may I be truly happy again until I return from my exile, and settle down to live out the rest of my life with them!

The 'Books' was begun as soon as I had acquired strength enough to do more than one thing – get well. It was designed to be a sort of glorified diary, setting forth the wonderful things that one finds in a new country.

Several parts have been included in the 'Fern Book': 'The little people of the rocks' (fossils); 'Wild Flowers' 'Studies of the Hills;' and the Ferns have been divided up into four parts. Then there are the 'Violets of the Ozarks,' and the 'Cave Book;' and the 'Fairies of the Fern,'

Fifty Years Study

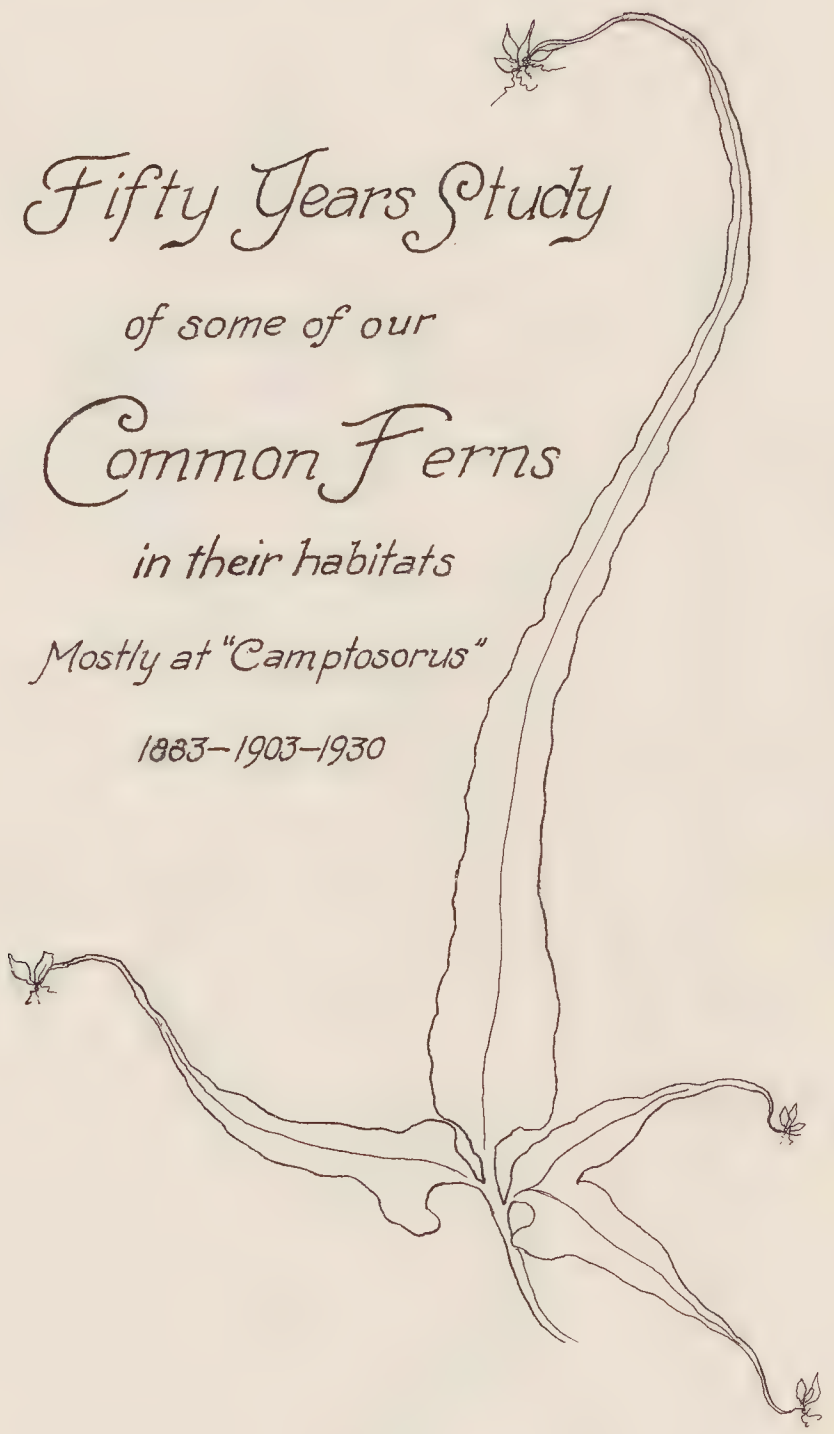
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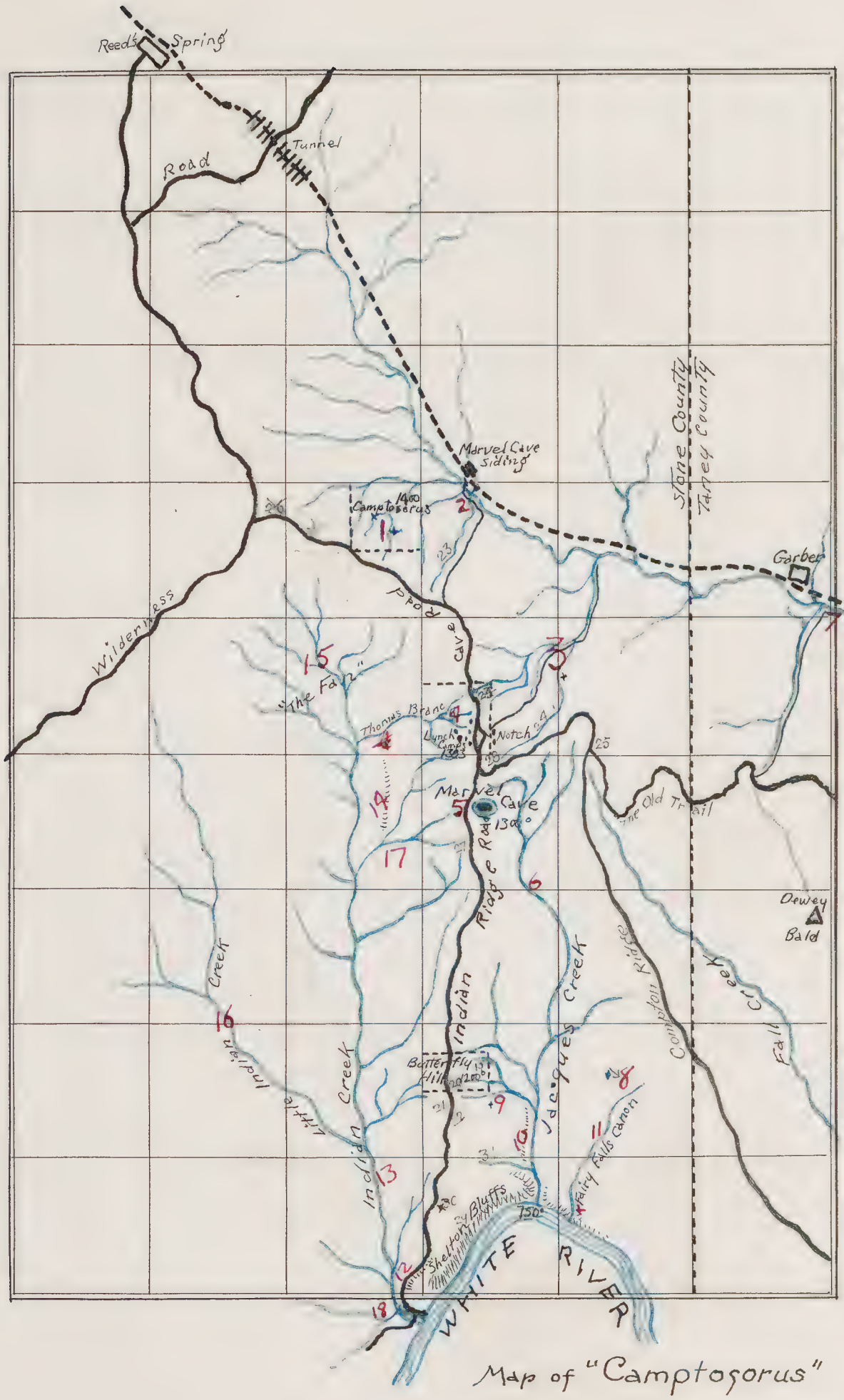
Common Ferns

in their habitats

Mostly at "Camptosorus"

1883–1903–1930





Map of "Camptosorus"
Showing Localities Referred to
in the following paper.

Dedication.

To my old Pal, Mr. W. H. Lynch, and to his two daughters, who have so splendidly aided and encouraged me in the pursuit of these studies, and who have made it possible for me to revisit the Ozark Hills and complete my observations, I affectionately dedicate this work.

S. Fred Prince

May 26, 1931

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Map of the Fern Country 'Camptosorus'
Dedication
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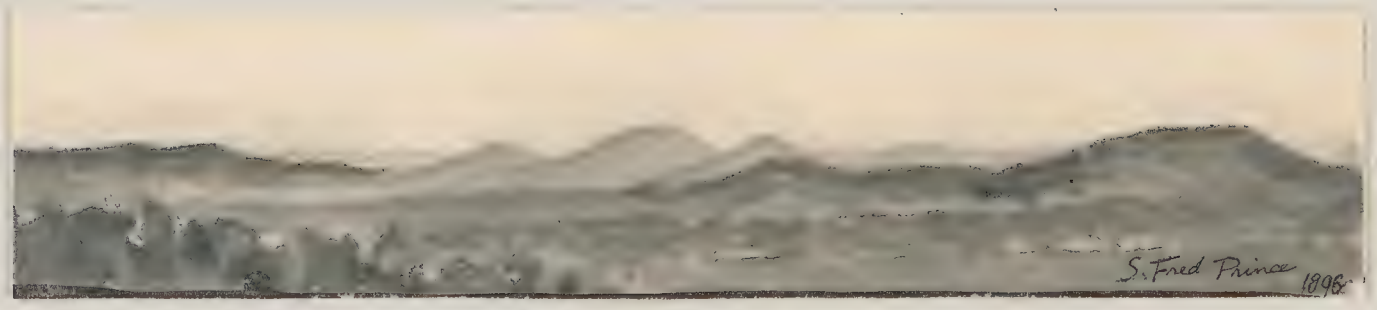
Results of Fifty Years Observation and Study of some Common Ferns in Their Natural Habitats, mostly at Camptosorus—Chicago 1885—1893; Camptosorus 1893–1928

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S. Fred Prince
1896

Results of
Fifty Years Observation and
Study of Some Common Ferns
in their Habitats—Mostly at
Camptosorus. 1885–1903–1928

Preface.

In 1915 it happened that I, in the quest for health, was privileged to live in that great wilderness of southern Missouri lying adjacent to White River, in Stone County.

The ferns were very abundant, every factor of perfect environment and habitat seeming to unite to make it a veritable fern paradise. Filled with enthusiasm he took up the study of his favorite plants in this virgin country.

A quarter section of land was secured and made the center of a field of observation and study extending from Indian Creek on the West to the East County line, and lying North and South between the Wilderness Road and White River. In all references to this area it is called "Camptosorus" (the homestead's name) which becomes the "Fern Garden."

Here these ferns were watched and studied in their native habitats, under natural conditions, for ten consecutive years, and at intervals for twenty-seven years since.

Sometimes they seemed to be as capricious as children at play. The Christmas fern

t'as not always the precise, decisive incisum —sometimes it was something else— and about the time you woke up to that, why, presto! it would change again. Other ferns had their challenge, also.

Studies were started; seeds sown, roots made, and weeds began. Colonies, groups and individuals were examined and recorded. Many individuals, and even groups were transplanted to observe the effect of altered conditions. Plants were raised from spores, roots, buds, cuttings, layers, etc. Studies begun many years before elsewhere were continued here.

For ten years a group of polypodium incanum plants were watched from the seedling stage to ascertain, among other things, how long it would retain its primary leaf. For fifteen years a colony of Adiantum capillus-veneris was watched for every phase of its growth and development, and— how long would one of its fronds live continuously? Thirty years to determine positively whether Polystichum acrostichoides incisum was variety or variation; 45 years seeking the true ultimate form of the sterile frond of Onoclea sensibilis.

But there were many other things to study before the life of these ferns could be understood, many of them as interesting as the ferns themselves. The birds and ravens the waters, and the forest. Having the ferns, an account of their habitat and environment became a necessity.

Camptosorus

Fred Paine

September 1928

Yet, I think it was mostly the artist in me that caused me to be so drawn toward this beautiful country, and the dainty beauty of its flowers and plants.

Foreword.

The absence from this account of many of those ferns which would naturally be expected to grow in a country possessing such ideal conditions, is mainly accounted for by the prevalence of forest fires and the grazing of hogs and cattle during the major part of the year, so that only those species growing in places inaccessible to those destroying factors are able to exist.

Since 1919, when the open range was discontinued, three ferns, ~~originally~~ previously quite rare, are becoming almost common. Botrychium virginianum, now often occurs on the high wooded hills as well as in moist ravines and bottoms. The range of Ophioglossum Engelmanni is extending rapidly, and Pteris aquilina may soon become as great a weed here as it is elsewhere. A few years hence, a quite different story may be written about the Ozark ferns, and probably many more names added to the list

The plan adopted was to make a comparative study of each fern in as many of its habitats as possible; its reactions when the conditions of its environment were altered, and when it was changed to a new locality. Each was

transplanted to the fern-garden, which comprised within its limits every condition to be found in the whole field of observation. Some were taken to other states and climates.

Not always was the reaction as expected--oftenest nothing at all beyond continued normal growth; but sometimes the response was surprising and demanded much intensive research and study.

There were not so many species, most of them the more common forms of the whole country, which fact, with their numerical growth and their growth-seasons, differing so widely from the calendar seasons, made them especially adapted for investigation.

Some of these plants varied greatly from their kind. These variations, many times on the same stem or brigade with the normal form, suggests natures' method in creating new species.

I find no need to mention just which authors are wrong; nor wherein lies their error. It requires scarcely more than a casual reading to see that the authors are guessing wrong or are quoting others who are wrong

These ferns have been rigidly scrutinized several times to ascertain whether or not at sometime they might differ enough to afford some reason for the inexcusable ignorance of many of our leading botanists.

So the only authorities I will cite are the ferns themselves.

In Parenthesis

It has been so persistently demanded of me by those in authority that I comply with academic usage by quoting authorities on the subject, that I feel compelled to give my reasons for not doing so.

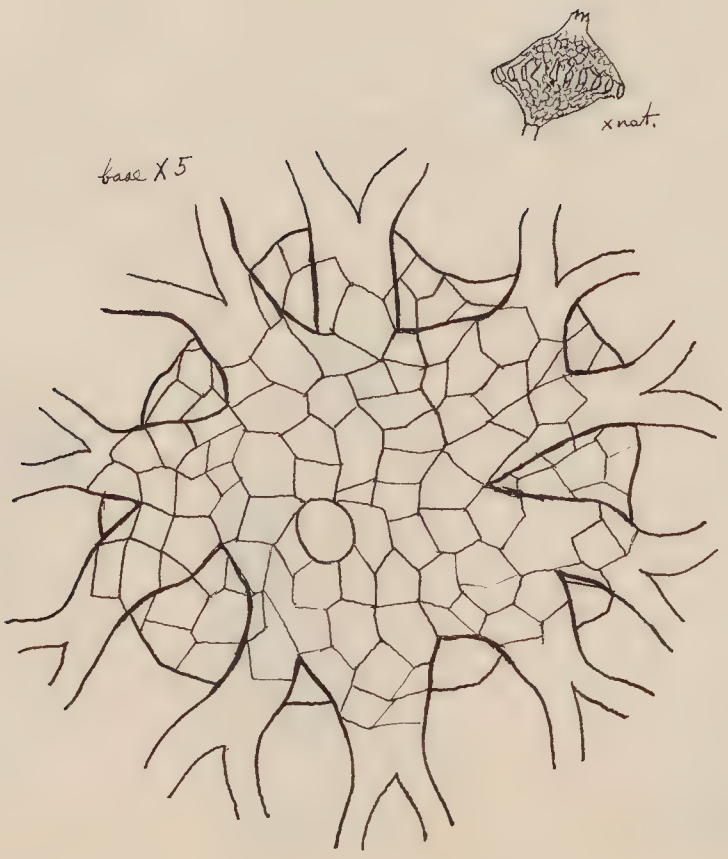
In the first place this paper was not intended as a criticism of the work of others, but simply as a record of my personal work and study of such ferns as grew most conveniently near, indulging in no theories, stating simple facts.

Because of the seemingly very general ignorance of the fern plant among writers on botanical subjects,— their slighting methods; the puerile guesses instead of honest investigation, and the manipulation of facts to fit their preconceived ideas, I had no intention of referring to the work of others, preferring to confine myself to a simple relation of my studies and their results.

Then, to quote them adequately would necessitate the compiling of a 'Digest of Pteriological Unknowledge' especially as to the more recent publications.

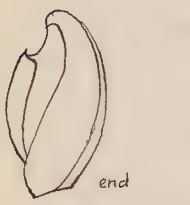
Part I — The Ozark Uplift in Stone County, Missouri

Including "The Little People of the Rocks" as proof of the country's place in the growth of the earth, and "The Wild Flowers."



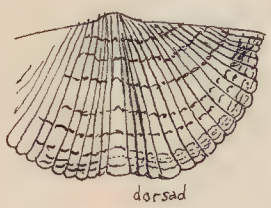
The general surface of the southern part of Stone County is very rough, being broken into long narrow, much-branching ridges and steep hills by deep abrupt ravines and canons ("draws" in the vernacular), with many rocky cliffs and bluffs.

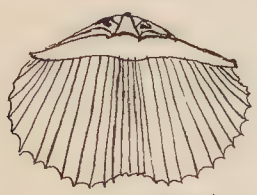
Tho a great many prominent points rise from the ridges, there are but few isolated peaks. Often the ridges are divided at the end forming a broad Y, both branches of which may rise into peaks, which drop steeply into the depths. Some are dome or saddle-shaped; others are conical, and many of them form interesting and conspicuous features of the landscape. Such are the Bread Tray, the Twins, Dewey Bald, Cedar Mountain, Turkey Knob, and others.





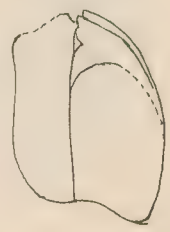


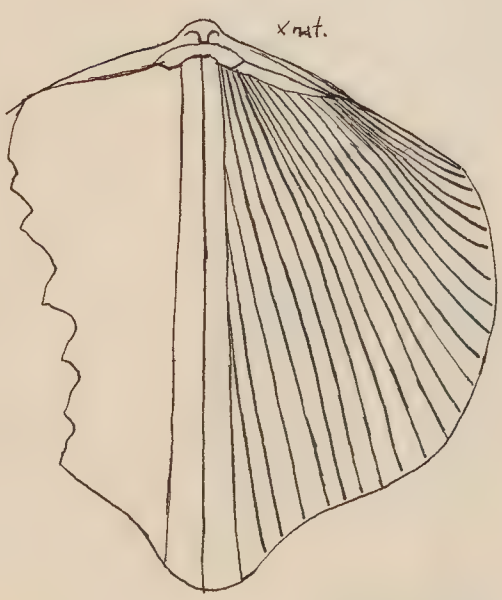


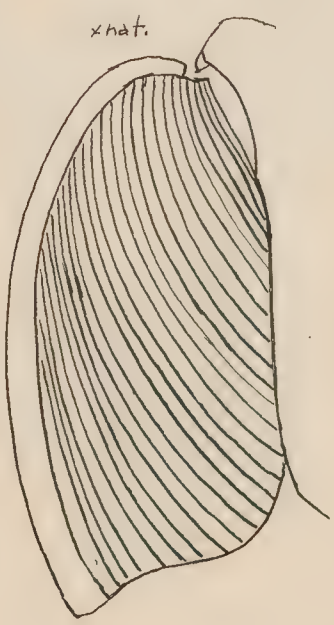


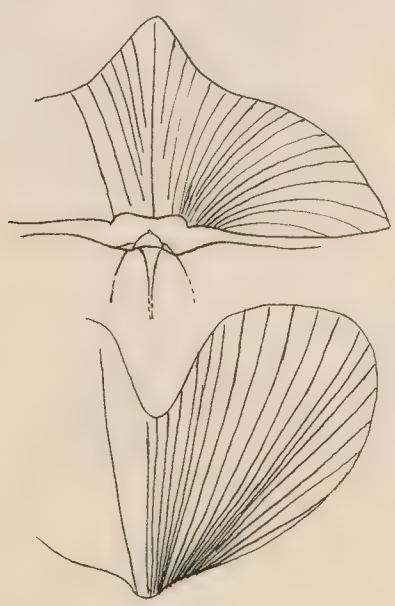
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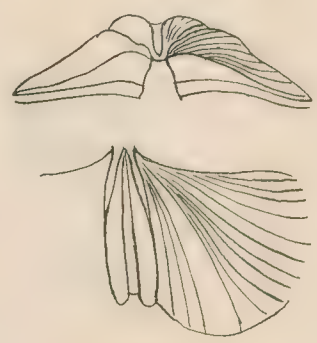
This part of the Ozarks, a complex of branching ridges, is called Mount Roark, and is difficult to delimit, except on the southern side where White River forms the boundary, entering the state in a great curve. It is joined by the James River from the North, and hundreds of small streams flow into these two. All the waterways are extremely crooked, and the water clear and cold.







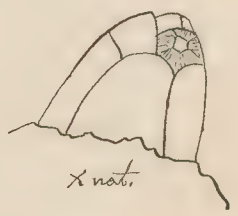




It will help our understanding of this country if we go far back in the history of the earth, for these hills are very ancient. The Ozarks were not formed by a violent breaking of the earth's crust, and the thrusting up of mighty fragments and piles of rock, as mountains of later periods were.

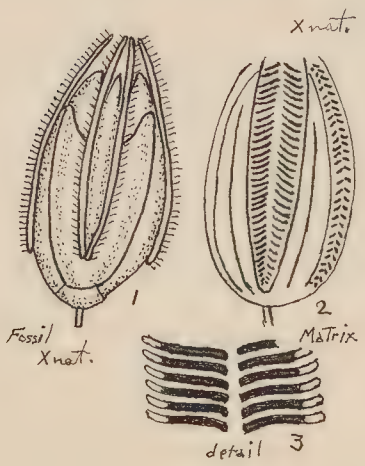
Here the rock strata are uniformly parallel, as formed by Nature, undisturbed in their relative succession. There is absolutely no trace of the terrific forces beneath having ever broken through.

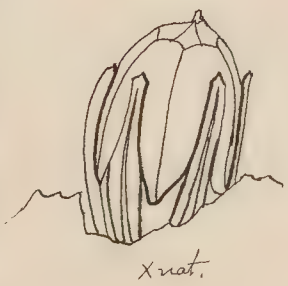
An outer crust had formed over the viscous compound that then was the earth. Accretions formed from within and from without. Water formed on the outer surface. Animals lived and died in those shallow seas, and their remains served to make the deposits thicker. Settlings and compressions of the crust occurred, causing great wrinkling and contortions of the strata. Other seas covered these rocks, and other strata were deposited. Ages and ages of this, and when the Silurian was about complete, mighty agencies beneath — expansion of the viscous mass, and the gases generated by it, reacted to the increasing restraints of the ever-settling and more rigid crust, and

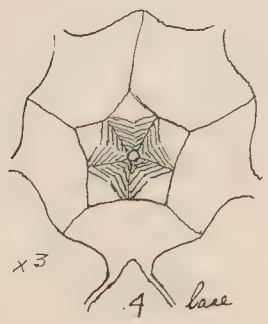


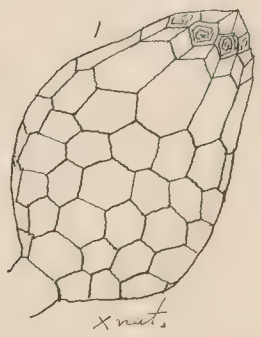








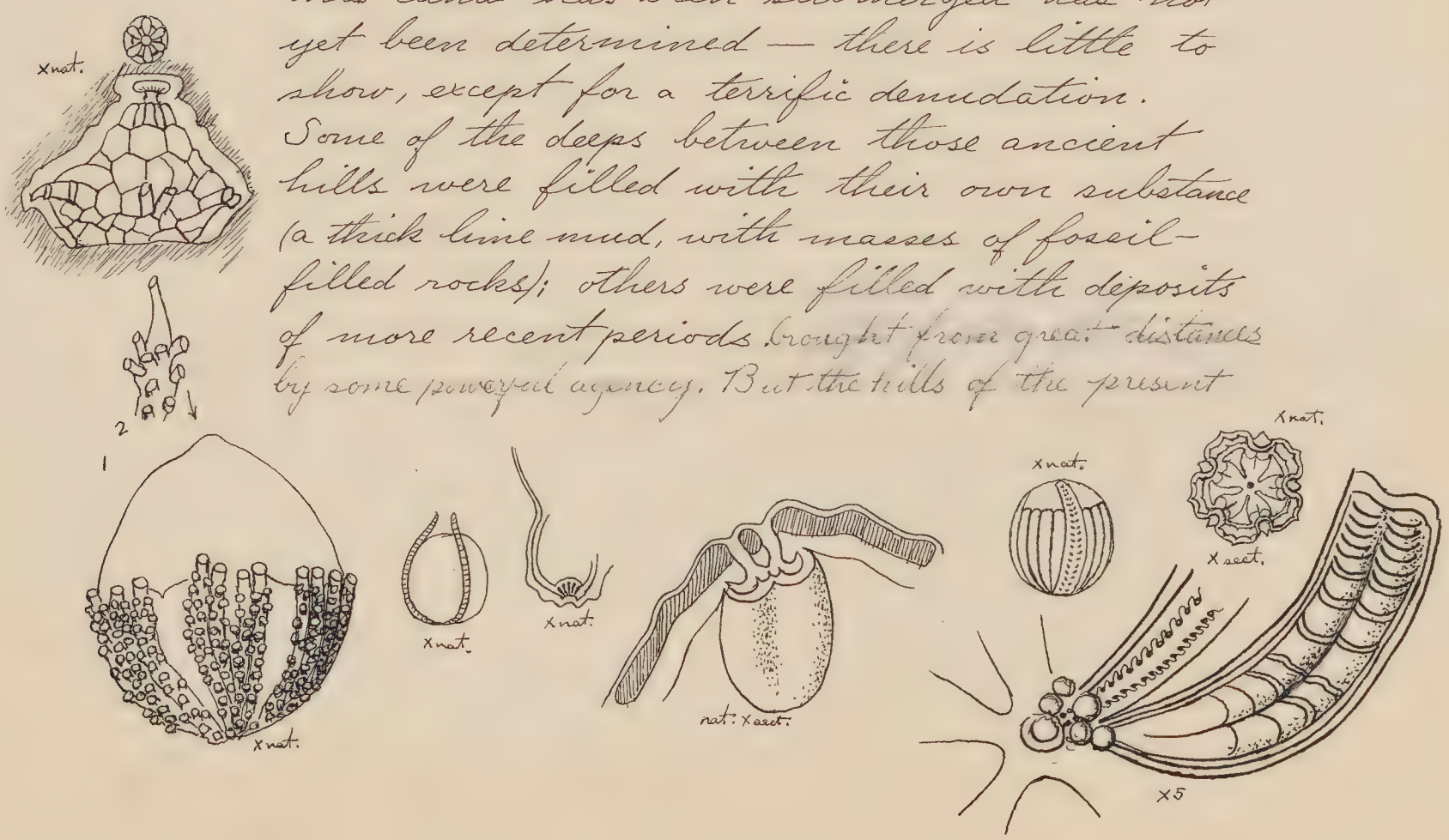




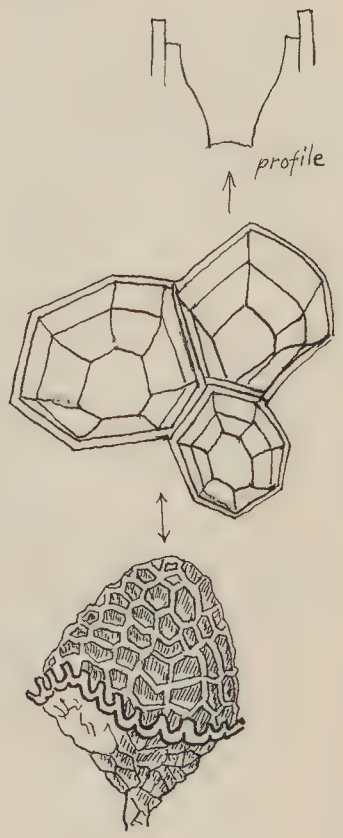
raised it in mighty waves and undulations forming tortuous, branding ridges. When tensions and strains were readjusted and balanced, another period of slow settling set in, accompanied by a tremendous erosion, shallow seas, and deposits.

Great fissures were formed in places, reaching deep into the crust; the strata broke into fragments at these points and fell into the cavities caused by the cooling and shrinkage of the internal mass. In these crevices and cavities occur the caves and caverns of the Ozarks.

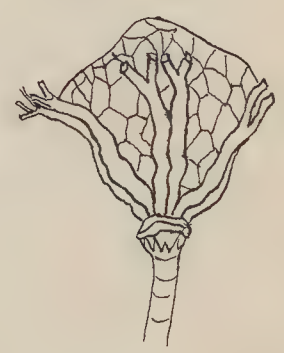
There were proportionately great depths between these mighty ridges, the highest points of which must have formed innumerable islands in the seas which covered the land. Slowly the land raised and the waters drained off to lower levels, carrying with them at least fifty percent of the once mighty range. How many times this land has been submerged has not yet been determined — there is little to show, except for a terrific denudation. Some of the deeps between those ancient hills were filled with their own substance (a thick lime mud, with masses of fossil-filled rocks); others were filled with deposits of more recent periods brought from great distances by some powerful agency. But the hills of the present

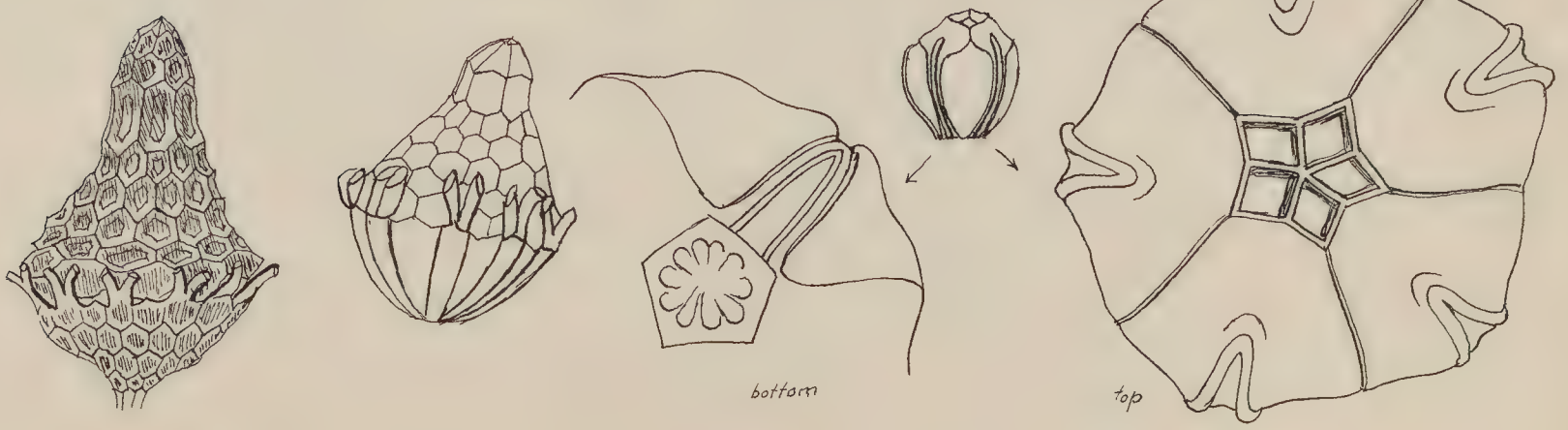


are but the remnants of the synclines of those giant curves. In those early days the upper curves of the hills were in the anticline of the strata, which sloped out and down, yielding readily to denuding agencies. In the present, the remaining strata are in the synclines of the curves, sloping back into the hills, forming natural basins which catch and hold the waters, letting the overflow escape slowly, preventing too rapid erosion, and causing deposits of the heavier materials. And so every ridge and hill has its caverns, its living springs, and its deposits of minerals.



'Sinks,' ~~or depressions~~ in the surface are very common throughout the country. They are funnel-shaped depressions varying from a few feet to several hundred feet across, with sides often nearly 45°. It has been found that they open into caverns located in the fissures above described, and in general, their size bears a direct relationship to the size of the cavity they communicate with. Marvel Cave is the largest of these caverns, and the room its sink opens into is, perhaps, the largest and finest underground chamber in the world. Evidently two small but deep sinks formed, later merging into one as the strata gave way. Below the bottom of the sink, there is a bottomless chasm some

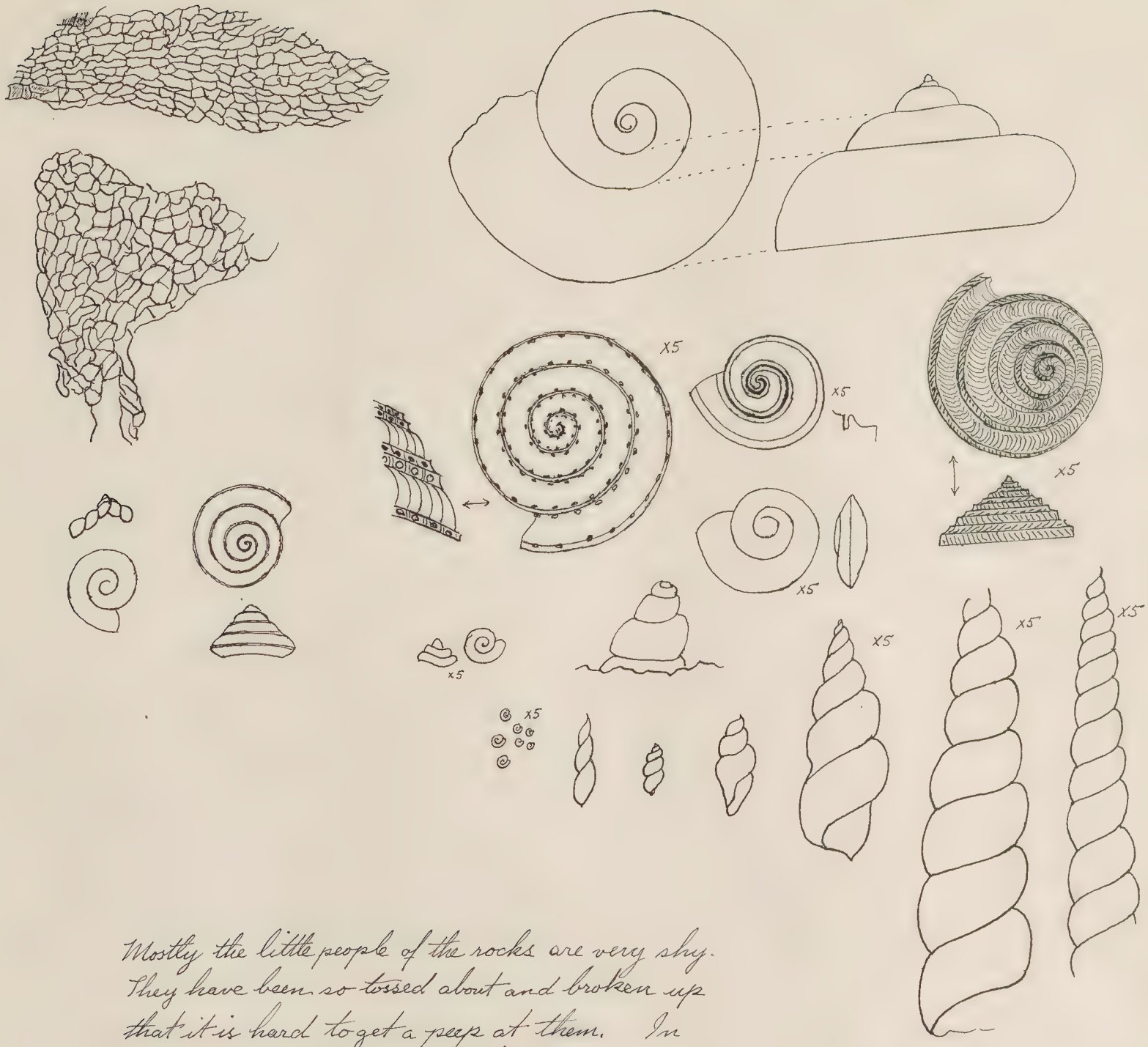




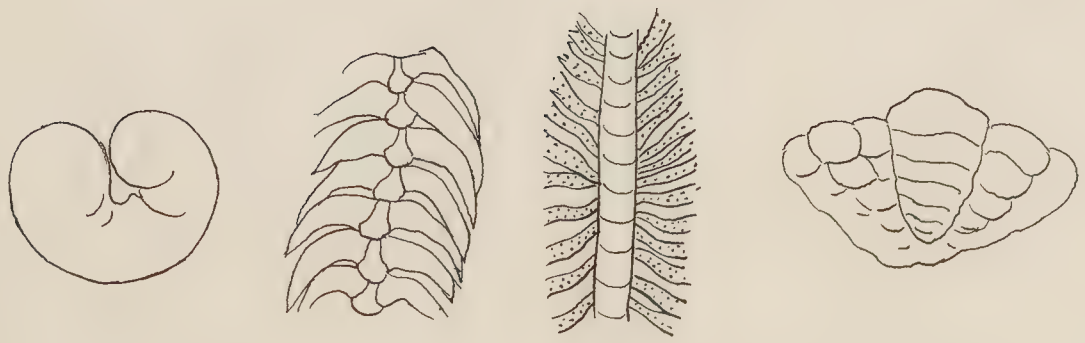
sixty feet deep, about two hundred feet long and thirty feet wide. The walls are precipitous, and jagged with projecting ledges. Trees and shrubs grow on the cliffs and the sloping sides of the sink. The great cavern below, with its lakes and streams, and many rooms and passages, creates a great uniformity of moisture and temperature ~~the~~ favorable to the ferns and mosses with which the rocks are covered.

Should be a picture of the
and cliffs at the entrance of the Cave





Mostly the little people of the rocks are very shy. They have been so tossed about and broken up that it is hard to get a peep at them. In many cases there is only the impression in the rocks where they have been, and there is little left to give us an idea of what they really looked like.



Most of the land is covered with a more or less deep deposit of angular fragments of a cherty, brittle rock which is constantly breaking up into smaller pieces with every change of temperature. They are dense masses of fossils of the brachiopods, crinoids, corals, and other animals of the ancient seas. Originally white, they change to pink and red in weathering, and enrich the soil with about every thing which the great forests and other vegetation needs.

The caverns and cavities of the region contain vast quantities of red clay, in which beautiful crystals of selenite are formed.

Besides the humus afforded by the plant life, the soil consists of this rock, a heavy light-colored clayey earth, a rich red color predominating in some localities.

In some of the deepest valleys there are outcrops of the Cambrian, and also of the Archaean formations, upon which the upper strata are conformably placed.

All the land was covered with the primeval forest — a much-mixed hardwood association, the Oak-Hickory Group in which the white oaks and shag-bark hickories predominated. There were the red and scarlet

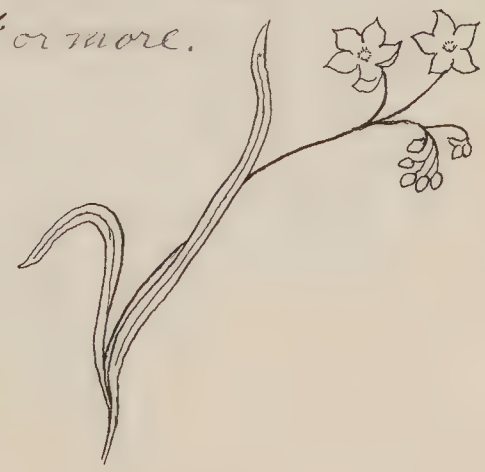
oaks, yellow, Spanish, and chestnut oaks; pignut and other hickories. On the slopes grew basswood, ash, elm, mountain maple, with here and there, red and black gum. In the ravines, on the bottoms, along the streams, were sycamores, the walnuts, sugar maples, oaks, hickories, hackberry, willows, and others. Towards the south this merged into the Oak-Pine Association — red, yellow, black, and Spanish oaks, tho sometimes these were also found in the first group. Bur and live-oak on the rivers. Scrub pine, short-leaf and yellow pine; post oak and black jack on the barrens, and elsewhere.



While the forest floor was not a jungle there was a great variety of under shrubs— dogwood, service-berry, ironwood, sassafras, red-bud, paw-paw, spice-bush, plum, grape, etc. The persimmon formed rather open groves of its own. Where the hardwoods merged into the pines, cedars ~~of several species~~ were abundant.



Many of the white oaks measured five feet in diameter. Sycamores were seven and eight feet; grape vines three feet, whose branches could be traced over fourth of a mile, grew in the bottoms where were trees whose first branches were at one hundred feet or more.



Many speceis of grass grew in this region; the Tall Grass Association from the North meeting the Short Grass – with the ample water making it an ideal grazing country.

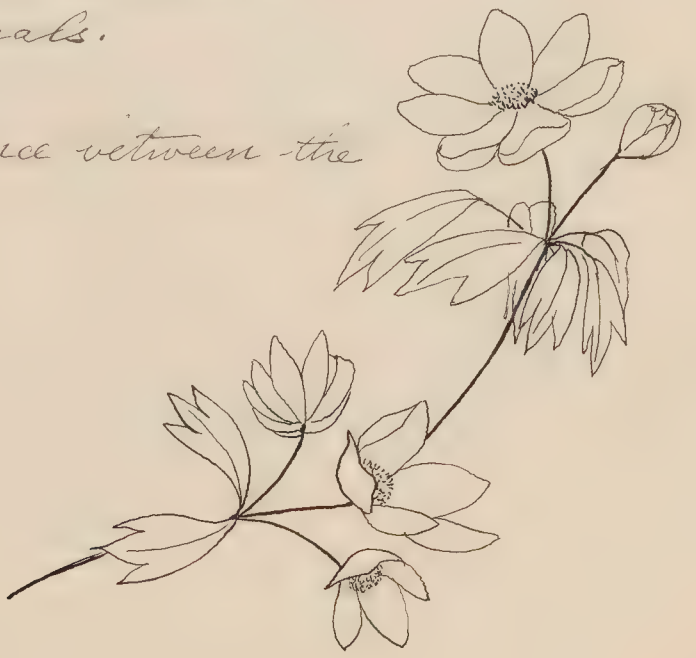
There was about every shrub and small plant that grows in the Mississippi Valley, and especially noticeable was the great variety and numbers of the Leguminosae. And about every known flower.

Here seemed to be the meeting place of the birds – in every season, from every – where. Many of them were only gay tour= ists come to spend the summer or the winter, then to flit away. There were always birds. In February and March, 1898, there were observed 160 song birds, and as many other kinds. In 1893–94, the writer saw what was, probably, the last pair of Carolina paroquets, which was at that time, officially extinct. Several pairs of Ivory-billed woodpeckers, also officially non= existent were accustomed to nest and breed in the woods of Camptosorus.

There were deer in the forest, also, in those early years and flocks of wild turkeys, and hundreds of quail. There were squirel, and fat, and wolves, and a great number of small animals.

There is a great difference between the





Northerly-Easterly slopes of the great ridges and the Southerly-Westerly ones. In the latter the "gravel" is more evident and bare; the forest becomes thinner, or is absent. Cliffs and bluffs stand out boldly, stark and bare— there are few lichens or mosses to cover their nakedness, or soften their sharp angles. Springs are fewer, weaker, and far deeper down. The plant-life is very different. On these slopes occur the "glades,"

On the opposite slopes there is soil mixed generously with the stones, sometimes entirely covering them. Stones and rocks are covered with lichens and mosses. The slopes are more gentle— there is heavy forest all the way; Springs are stronger and far more numerous; there are wet mossy cliffs and ledges, fern-draped rocks, — a rich undergrowth



Some of the rock strata are metaliferous, carrying zinc, galena, or even copper. The same peculiar influence which seems to exert such a modifying power on most all things exposed to the South and West, apparently affects minerals also. The characteristic cubes of Galena which are very numerous - in some of these strata become altered as the exposure swings to the South, and without change of shape, reacts







as something entirely different.

Owing to the curving nature of the ridges there are many ravines which may start out in one direction and soon bend away in another. The cliffs may begin in the heavy forest, and with ample moisture, the ledges damp and covered with mosses and ferns. Its line bends around to the West. The forest thins out; ferns and mosses and moisture disappear. A different grass occurs on the slopes; trees give place to shrubs, and even they are different. A complete change has taken place in the environment, and everything else has changed also.



There are, however, many anomalies. At the river end—West-Southwest slopes—of Indian Ridge, there is rich woodland and a fine, large everflowing spring. Skirting the ridge for a mile on its Western side is a low ledge of siliceous limestone from which ooze many springs; and there is a thin woodland to give shade to the many species of ferns which grow luxuriantly on those rocks.



The dolomites, or magnesian limestones are conspicuous and important rocks in this country, the thickest strata being used as a





building stone. "Cotton-rock" is quite soft when first quarried and is easily quarried hardens when exposed to the air, and holds its white color. Nothing will grow on it, and the white lines of its strata may be traced for miles down the sides of some valley. Sometimes all the strata above it has been eroded away, leaving the tops of magnesian exposed. From a high ridge overlooking the Roark valley there may be seen a long line of white-topped hills — the "Bald-Knobs" of fame and story.

In the north part of the county the hills and ravines are broader and shallower, and there are even brooks flowing through grassy meadows!

The forest is not so dense, and the land is more thickly settled. Towards the South the ridges become higher and steeper, the ravines more like canons, deeper, narrower, more abrupt. One that drops down from the Cave Hill through the heavy oak forest toward Indian Creek challenges ones admiration. At first, a broad shallow dip in the curve of the great hill it drops steeply with alternate flatter areas like lawns. Then it changes into a rocky gorge, with a sparse growth of small trees, hills, heavily-wooded, hills rising steeply on every

side. A noisy, shallow brook tumbles over the edge of each strata a foot or so to the next one below. A half mile and the hills fall steeply into a broad sloping bench, the stream gets narrower, noisier, and suddenly jumps over a last ledge into a rock-bound pool ten feet below, surrounded by heavy oak woods, and then runs off merrily to join Indian Creek a half mile away. The "Fairies Bath" is a lovely spot. The almost semicircular cliff is hollowed under, and there is a broad rocky ledge a foot above the water. The surrounding walls are covered with ferns.

Indian Creek is a murmuring, romantic stream wandering here and there through a wooded valley, a quarter mile wide. Mostly it flows under its bed, as so many of the streams do in this country. It flows about six miles to White River, showing permanent water in its bed from about halfway.

Great offshoots from Indian Ridge jut into the valley from the East, descending steeply, often precipitously, sometimes ending in high, rocky cliffs, each ravine with its own little watercourse.

From the West the branches of the Great Coon Ridge break down abruptly into a gently sloping "bench," about half a mile wide, which falls rather steeply into the valley. This "bench"



is broken up by numerous torrent courses from the precipitous ravines of the main ridge. A few of these "hollows" send streams to join the Indian.

The largest branch, Little Indian, is scarcely half the size of the main stream and is particularly interesting because of its origin and course in a region with a very different and later geological history as shown by the composition and fossils of its rocks.

Fairy Falls Canon though small, is one of the finest. A rocky, rugged gash in the rock, not over a mile long, it drops about two hundred feet into White River from the North. Its whole length is in the dense forest, and except for a space of about five hundred feet near its mouth shows every evidence of being "young" (geologically). Its rock-masses are sharp-angled and bare of moss or lichen, as are the trees in its course, but few plants grow on the ledges. A little stream purls and gambols among the rocks, leaping over mimic precipices, dropping musically into pigmy lakes, tinkling and singing, chattering and gurgling on its way. Near the river it ~~is~~ enters the denser shade of the older portion among giant old trees. Here the cliffs and rocks, and boles of trees, are covered

deep with moss, and ferns are everywhere. Against one cliff, a great slab of rock, fallen from the upper strata rests on one end against the cliff - it must be thirty feet high and is covered deep with moss and lichens forming a bed for a dense mat of magnificent waving ferns. With its many miniature waterfalls this glen is a place of beauty to dream about.

The "Iron Springs Hollow" has its beginning in the union of numerous small ravines, each having a large quota of clear cold springs, of fern and moss-draped cliff, of woodland beauty and charm. It is an adventure of delight to explore each seductive path in turn. In one of these ravines are two large springs of coldest purest water, bubbling up through the gravel, a rare occurrence. Undoubtedly they are one of the outlets for the waters of Marvel Cave, a mile away. There are several other springs in the vicinity, gushing from the ledges of the fern-covered bluffs. A little creek flows eastward through a narrow valley, singing over its rocky bed, cold and clear, as all these Ozark streams are. On one side is a long line of high cliffs - on the other the great ridge breaks down into hilly benches. All along the two miles to Roark there are springs, and all the way is in the

thick, unbroken forest, one of the most beautiful spots in this beautiful country.

Roark Creek, the biggest little stream in the district, rambling, shallow, clear and cold, murmuring and tinkling over its stones, wandering all over its wide valley; may, like all the other water courses in the region, become a raging mountain torrent in an incredibly short time. Beginning near Reed's Spring in two long branches, it flows southeast fifteen miles, joining White River near Branson. There are low cliffs and bluffs and altho its valley is the most thickly settled part of this region, much of the original forest remains, especially in the upper half of its course. On one of its bluffs is the only station for our rarest and most beautiful fern.

There are hundreds of other beauty spots — let the feet stray where they will there is the loveliest spot of all. And the finest fern habitat is this area lying to the East of Indian Ridge — "Camptosorus!"



With few exceptions ferns are not found here on the uplands — in the "high woods." Neither are they found in the low lands in such profusion as one would expect. The fern zone lies about two-thirds

the way up the ravines and cañons. The wind sets up these "draws," loses some of its moisture part-way up, and passes over the ridge much dryer. The movement can be seen on cool mornings and evenings after heavy rains, when fleecy mists float up the hollows.

Very heavy dews characterize the Ozark Hills, lingering long in the ravines and on the "bottoms." The rains, also, were heavy, but very seldom long continued.

The winters were short and mild, and the seasons seemed to loiter along quite casually. Spring faded gradually into summer—into fall—and it was spring again. There was scarcely time for the peach trees to reluctantly shed their leaves before they were blossoming again. The ferns, in their protected habitats, were not killed, even in the longest and severest winters. Usually the first frost was about January 15.

Hardwood forests require a very great humidity and precipitation, so we should expect high records from so heavily forested an area. At Galena, December 24, 1896, occurred their first frost. At Campstosorus, south end of the county there was no frost, and the hills were covered with wild flowers



The following are averages for the ten years, 1593—1902, inclusive:

First frost about January 15

Several light snows, mostly melting on reaching the ground

Occasionally snow lying on the ground one to several days

Plowing by February 15

Mist or fog	4 days	Number of times snow 12–30	
Cloudy	30 "	" " " "	snow all day 4
Earliest snow	Dec. 23	"	" days snow cover 3–4

Average Relative Humidity—per ct.

	8 a.m.	2 p.m.	8 p.m.
January	90	70–80	50–60
April	90	50–60	40–50
July	90	60–70	60–70
October	90	60–70	60–70

Average Monthly Precipitation

60–70 per ct. falling at night 1893–98; 40–50 per ct. falling at night 1899–1902

	no. of days	Inches		no. of days	Inches
December	6–9	3–6	June	9–12	4–6
January	6–9	3–6	July	12–15	5–7
February	9–12	4–12	August	6–9	3–5
March	12–15	5–10	September	9–2	6–10
April	12–15	5–10	October	6–9	6–10
May	12–15	5–10	November	6–9	6–10



Part II
The Ferns and their allies Collected and studied at "Campto-sorus," 1893 to 1930.

Check-list of the Pteridophyta

Found and Studied at "Camptosorus"

Adiantum Capillus-veneris L. Venushair Fern ~~71, 73~~ 65, 66
" pedatum L. American Maidenhair ~~75, 77, 79~~ 67, 68, 69
Asplenium ebeneum Ait. Ebony Spleenwort ~~81, 83~~ 70, 71
" " serratum (Miller), ~~83~~ 71
" parvulum Mart. & Gale Small Spleenwort ~~85~~ 72
" trichomanes L. ~~87~~ Maidenhair Spleenwort ~~87~~ 73
Botrychium virginianum Virginian Grape Fern ~~89, 91, 93~~ 74, 75, 76
Camptosorus rhizophyllus Link. Walking Fern ~~95 to 119~~ 77–84
Cheilanthes lanuginosa Nutt. Woolly Lipfern ~~121, 123~~ 89, 90, 91
Cystopteris n. sp. (bulbosus?) Broad Bladder Fern ~~125, 127~~ 92, 93
" fragilis Bernh. Fragile Bladder Fern ~~129, 131~~ 94, 95
Equisetum arvense L. Common Horsetail ~~133~~ 96
" hyemale L. Scouring Rush ~~135~~ 97
Notholaena dealbata Kunz Whitened Cloak Fern 137 98
Onoclea sensibilis L. Sensible Fern ~~139, 139+, 141, 143~~ 99–102
Ophioglossum Engelmanni Prantl Adderstongue Fern ~~145, 147, 149, 151~~ 103–106
Pellae atropurpurea Link Purple Cliff brake ~~153, 155, 157~~ 107–109
" trifoliata n. sp. Little Cliff brake ~~159, 161, 163, 165~~ 110, 111, 112
Phegopteris hexagonoptera Fee Oak Fern ~~167~~ 113
Polypodium incanum Swz. Gray Polypody ~~169~~ 114
Polystichum acrostichoides Schott Christmas Fern ~~171, 173, 175~~ 115, 116, 117
" " incisum Und. Incised Christmas Fern 171 to 175
Pteris aquilina L. Eagle Fern ~~177 to 191~~ 118 } 119
" caudata Tailed Bracken ~~177 to 191~~ } 120
Woodsia obtusa Torr. Obtuse Woodsia ~~193, 195~~ 121, 122

Adiantum capillus-Veneris L. Venus hair Fern.

This is one of our rarest ferns, occurring in but one locality. It was first found by the author in 1915, growing on the perpendicular face of a lime-stone cliff (?) in the deep shade of the oak forest. The seepage from a small spring above kept the rock always moist. This rock was a soft, rather rotten, whitish limestone

At this time there were but a few trailing plants on the cliff, and two upright, bunchy plants on the talus below. Fronds not longer than six to eight inches.

By 1926 they had increased in size and number so as to cover several square yards of the face of the cliff rather densely with their pendant, graceful fronds, quite hiding the rock.

The plants on the talus, with stricter fronds, growing upright, in crowns, were quite different in appearance, and 12"–15" long, had also increased in size and number.

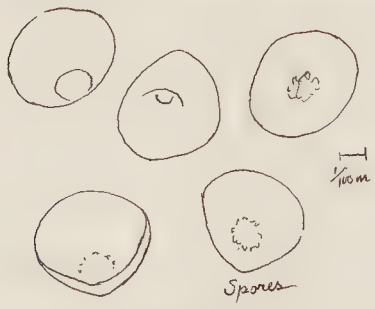
In the fern-garden the plants grew well when planted in soil taken from their original habitat, but all efforts failed to get them to grow in ordinary soils.

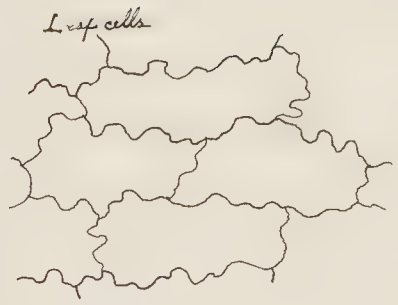
The first pinna is usually on the right of the rachis, but occurs occasionally on the left of it. The first superior pinnule is next the rachis.

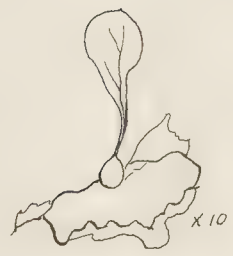


Rhizoma x nat.

Adiantum capillus-veneris















Adiantum pedatum L. American Maidenhair fern.

There were four groups of this beautiful fern in "Camptosorus," the largest of which was in a broad shady ravine, where hundreds of plants were growing among mossy stones on a rocky bottom over which flowed the clear cold waters of a never dying spring.[1] This was a beautiful spot on the old homestead.

A second group was near the great Cave, in the head of a shady ravine,[5] high up on the hillside, where a spring, buried beneath a mass of mossy stones, kept the air, as well as the ground, constantly moist. There were several hundred plants on the sides of the very steep slopes.

In the third group, on a mossy ledge, dripping with water, near the base of a cliff on Indian Creek,[8] there were not more than a dozen plants, and in a similar location, a half mile away there were about thirty plants.[13]

All these plants were normal, comparing well with those from other places

There has never been any seasonal resting stage evident.

They take very kindly to cultivation, and are much sought after as garden and house plants

Adiantum pedatum



To show twisting of the rachises

Adiantum pedatum



When the twists in the rachises of Adiantum pedatum are straightened out, all those solitary pinnules, which so oddly occur between the fully developed pinnae, will fall upon the opposite side in regular alternate order, their form and position suggesting that they are the terminal pinnules of otherwise suppressed pinnae.

These twists are easily seen, and are very marked in dried specimens.

The Rock Asplenium.

The Rock Asplenium are among the most common and widely distributed ferns in this part of the Ozarks. One or all of them are certain to be found wherever you may be. They prefer to grow in rather dryish, well-drained soil or in crevices of rocks, and they endure the severest droughts, folding their pinnae back against those of the opposite side, covering the sporangia. This is also their sleeping position, and is confined to the fertile fronds.

Their best development and greatest development is attained where the air is constantly moist. It is a common habit of all four for the fertile fronds to shed their pinnae as the spores ripen, these being articulated to their very short stalks, and falling independently.

The sterile fronds make their growth during the fall, winter and spring, the fertile ones following them.

They all transplanted well, taking to the changed conditions without setback or modifications.

Asplenium ebeneum Ait. Ebony Spleenwort.
Screw fern. Zig-zag fern. Ladder fern.

While perfectly at home in the thin stony soil which covers most of these hills it grows most luxuriantly in deep, shady hollows where the air is moist, or mossy ledges and in cavities on the sides of boulders. The sterile fronds are small, thin, and herbaceous, bright green, forming a rosette close to the ground. The fertile fronds are tall, stiff, thick, and leathery; the pinnae are so regularly alternate as to give a zig-zag appearance to the frond.

Asplenium ebeneum serratum (E.S. Miller) B.S.P.
Incised Spleenwort.

Except for its incised or serrated pinnae this is exactly like the species in its appearance and habits

Asplenium parvulum Mart. & Gale. Small Spleenwort.

The Little Ebony Spleenwort might be mistaken for the Maidenhair Spleenwort, but is more leathery and rigid, the fronds standing up more straightly, the pinnae deflexed and narrow, and opposite each other, and all the fronds, fertile and sterile like each other in size and color.



Their fronds are densely clustered at the ends of the very short rhizome. When dry, or resting, the opposite pinnae closely approach each other covering the fruiting side.

Asplenium trichomanes L. Maidenhair Spleenwort

This is the smallest and daintiest of the four Rock Aspleniums, and grows on mossy ledges and boulders where there is ample shade and moisture. It is not so common as the other three.



Botrychium virginianum Swz. Virginian Grape Fern.

Mature plants appear to be identical in every way with those from every other part of the country. Their annual appearance at the same dates as elsewhere, in spite of the far more advanced seasons, probably indicate a more northern origin

Removed carefully they have taken hold readily in their new quarters when transplanted, even to alien soils, except when put into light sandy soil, when they soon died.

Occasionally plants were found bearing two fronds, some of which were found to arise from a very short branch at the side of the crown; others were undoubtedly the frond of the next year appearing prematurely.

A few "sports" appeared now and then, but not in sufficient numbers to be of any significance.

Several masses of young were found growing in a soil of finely dessicated humus near an overhanging ledge which protected them from beating rains, and from being washed away.

There were Prothallia and young of all sizes, and easily studied *in situ*. The very youngest were thriving among the particles of the top soil. Their depth in the soil appeared to increase with the size and development of the plant. The parent was rooted in compact clay soil at 5 eight inches. Those downward growing roots - the pull-roots must be the main cause of these plants growing so deep; then their growth from the crown downwards, as in *Ophioglossum*.

Botrichianum virginianum.

The rhizoma grows very slowly. A large number of fine old plants were examined, the largest measuring ¼ to ½ inches across, one to one and a half inches long. Cross-sections plainly showed the fronds of fifteen years folded within each other. One of the plants which had produced sterile fronds for two years previous, showed a fertile frond for the present year, already two inches long, and ready to shoot above ground. In the section the next two would be sterile — the third fertile. Similar results were obtained from other plants, some showing six or more embryo fronds whose form could be recognized.

It may take the frond of the older plants, which are 6–8 inches deep in the ground, four years to mature and reach the surface.

Already formed in all its parts, once it leaves the cavity, it seems to grow in spurts, pushing up rapidly when the ground is softened and loosened by rains; resting and gathering strength between times. It is not uncommon for the frond to be injured in some way when at last it reaches the surface.

A very large number of plants were used to ascertain whether, by persistently destroying the fertile ~~fronds~~ segment the sterile segment could be forced to produce sporangia. Absolutely no results were obtained after

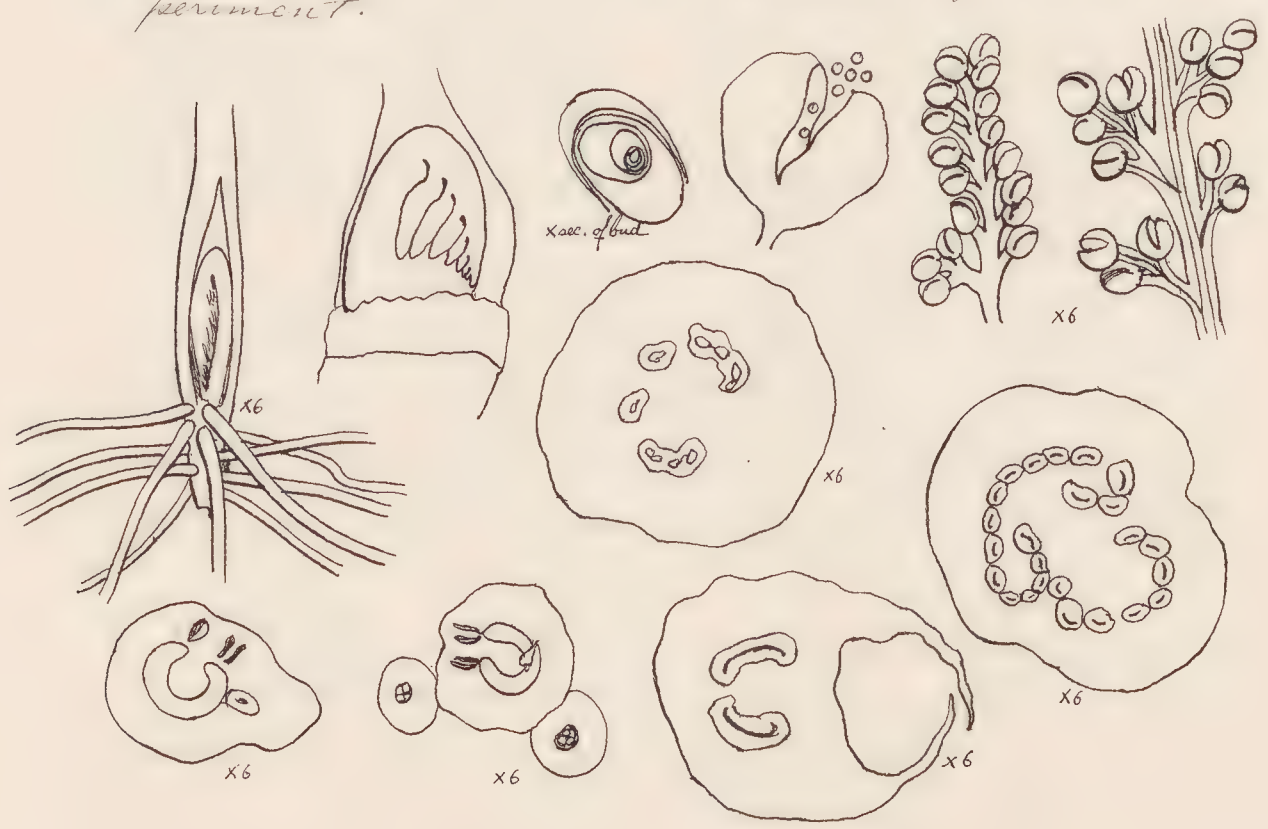
Botrychium virginianum.

several years. Also, by removing the frond altogether whether the plant would produce a completely fertile frond.

Knowing that the fronds were prepared so far ahead, these experiments were simply in the nature of a demonstration. In the second experiment the plants died for lack of foliage.

Some response might be obtained to the first experiment if it were carried on for six years or longer, when the fronds already prepared by the plant had passed and the succeeding ones prepared <u>after</u> the beginning of the experiment could be examined.

If a fertile frond had appeared any sooner than this it would simply mean that it had appeared in its turn, and was already prepared, and was not affected by the experiment.



Camptosorus rhizophyllus Link. Walking Fern.

Like the Rock Aspleniums, the Walking Fern is very common in this country, growing everywhere, anywhere, where there is a bit of rock with lichens and mosses to form a bed to grow in.

Moisture it must have, of course, and when the moisture is constant, it reaches its finest development and greatest beauty.

In drought, or air-dry times, it rolls up and crumples, and dries to powdery brittleness, but very quickly resumes growth and vicacity when moisture is restored.

A long undisturbed growth seems to be necessary and the most potent factor in its development.

The great differences presented by this fern in its various habitats made it necessary as well as convenient to study the plant by its natural groupings.

These groups were arranged in a sequence based on the variation in the form of the base of the frond from simplest to most complex, as shown to be the prevailing type in the group. There were no sharply defined departures from the type such as to suggest a difference in species, and there was always fronds of the

* The two forms of frond common to the species here, does not seem to be mentioned by authors. The long pointed leaf whose tip becomes very narrow and elongated, almost stolon-like, and attains sometimes to two feet; the other form is broader with a rounded apex which never alters; this form may or may not bear sporangia.

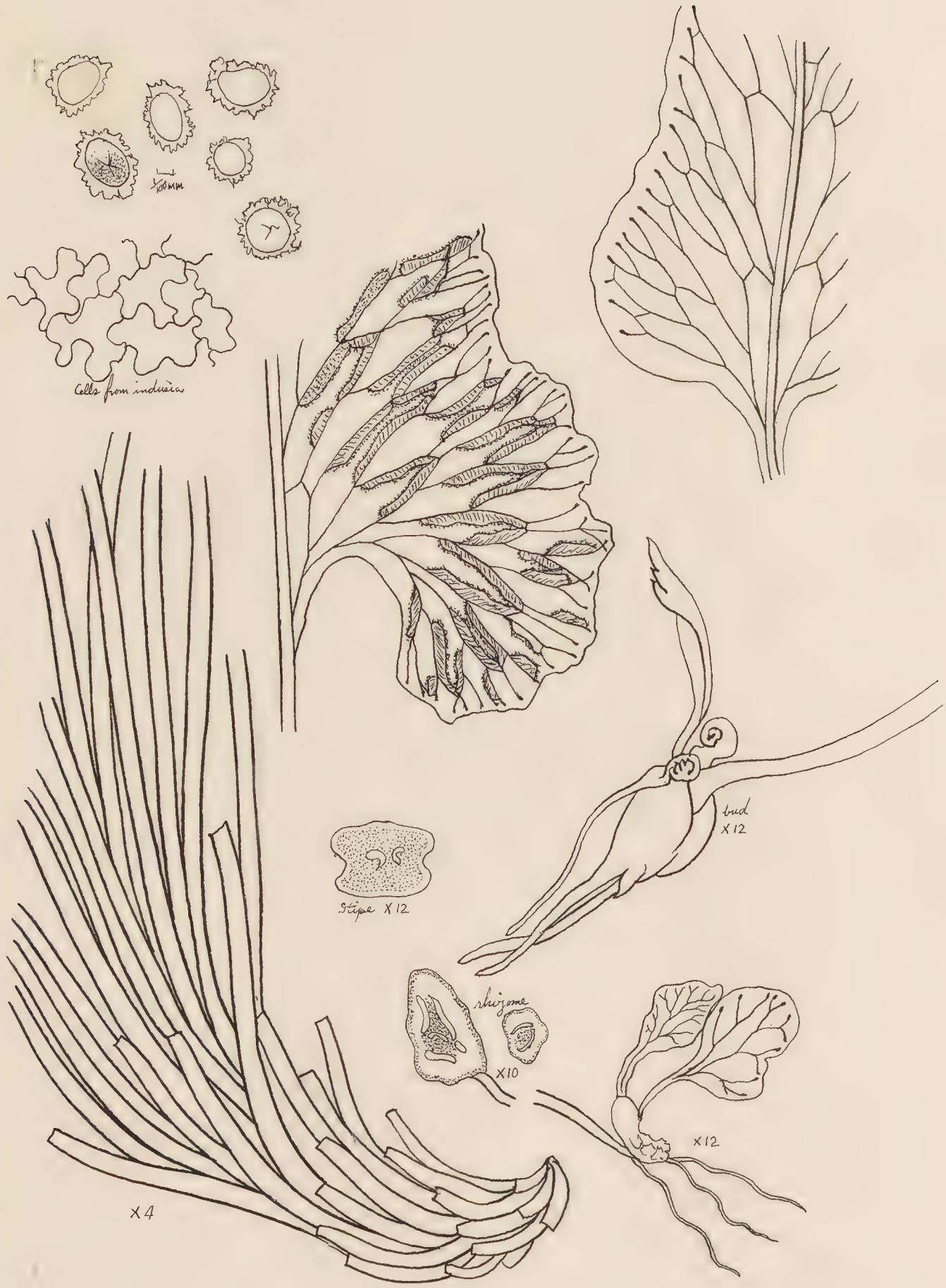
simplest form in each group. This simplest form appears to be the prevailing type all over North America.

For many years they were studied for constancy of form, not only in their own habitat and alterations in their environment, but also in the new conditions to which they were transplanted. Rooting only in the mosses and lichens covering the rock, they were very easily handled, and quickly responded to care

Taking up the groups in detail, their arrangement is as follows:

1. Marvel Cave Glen.
2. Iron Springs Hollow
3. Roark Creek
4. Dutchman's Spring
5. Persimmon Hollow
6. Indian Creek
7. Jacques Creek
8. Fairy Falls Canon

Camptosorus rhizophyllus



Camptosorus rhizophyllus.

1. Marvel Cave Glen. This is a fissure through the rock strata from what was once the bottom of a large sink. There is no bottom, the chasm opening into a great chamber of Marvel Cave. The walls are precipitous, rough and jagged with projecting ledges, which are covered with ferns and mosses.

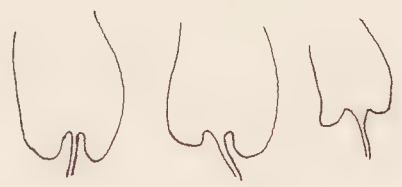
There are distinct zones of temperature and moisture quite sharply marked, and varying slightly with the seasons, the range being between 45°F and 60°F at the lowest ledge. Here the mosses grow luxuriantly the ferns finding more congenial temperatures above.

The Camptosorus compare well in size and form with those obtained from other places in the United States, and are of the average type.

Because of the constancy of temperature and humidity in this habitat, none of its ferns survive removal to the outer atmosphere but thrive in a moist-chamber.

Camptosorus rhizophyllus.

2. *Iron Springs Group.* — These differ little from the type, except in a tendency toward lobing at the base, but never deeply or broadly. The conditions in the many ravines, where every rock is covered with mosses and ferns, where there is ever present moisture and shade, would seem to make the spot an ideal one for *Camptosorus*. It is every where, often covering the rocks in dense mats. Accompanying it, in this ideal habitat are the *Rock Asplenriums*, *Cystopteris*, *Woodsia*, *Pellaeae*, etc. etc.



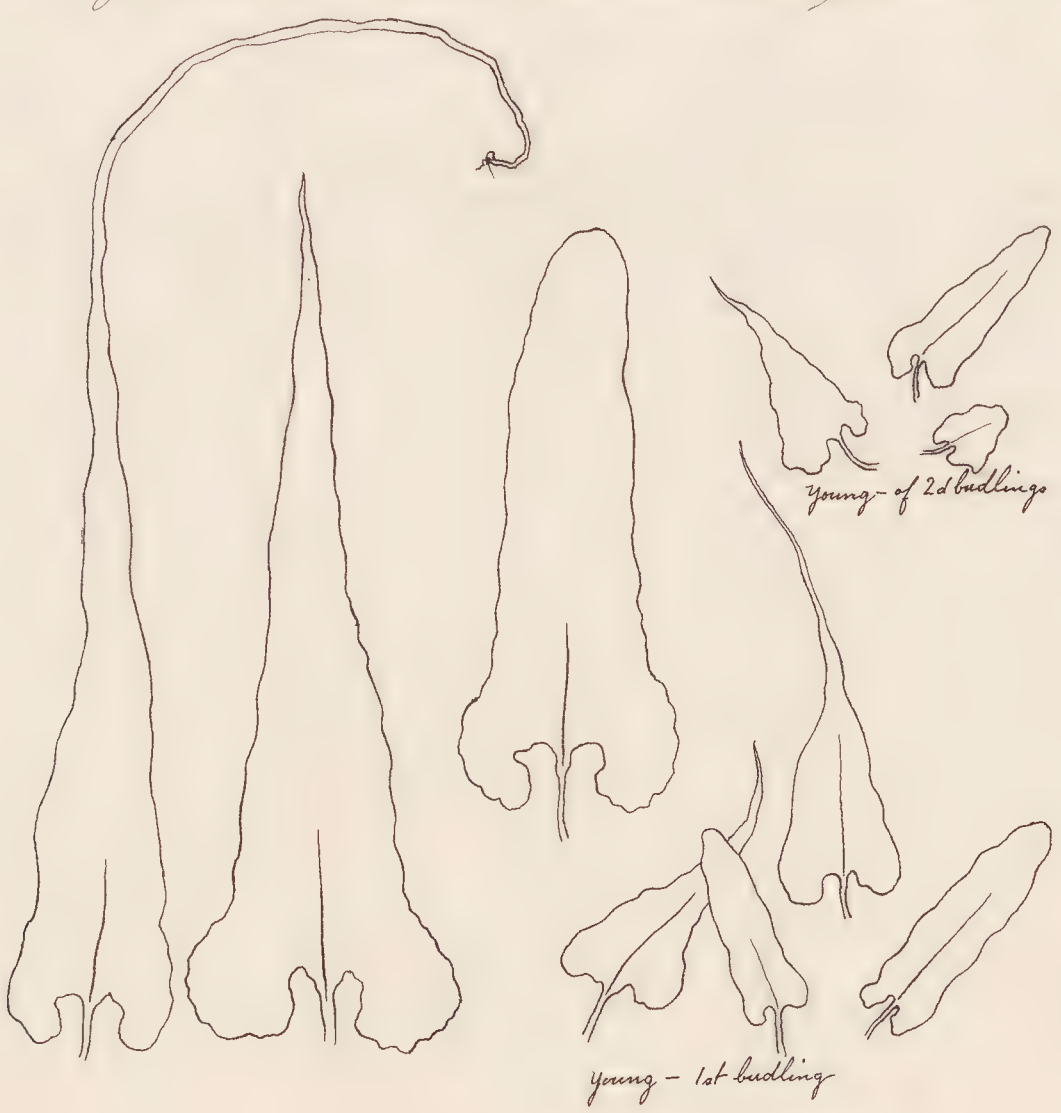
Camptosorus rhizophyllus.

3. Roark Creek Group. Covering so large a territory, with the varied conditions a long, wide valley offers, a great range of variation might be expected. The type, however, is very uniform, the vases be generally somewhat more deeply and broadly lobed than in 1; and 2.



Camptosorus rhizophyllus.

4. *Dutchman's Spring.* A considerable stream of water flows out of a cavity in the rock and runs off in a little ravine of its own, between cliffs of limestone. Large moss-covered boulders near the spring and in its waters are covered with this large and beautiful fronds. The little gorge is entirely in the deep shade of the forest, and its head is almost choked with ferns and Hydrangeas. In common with the species, the sterile frond is never proliferous, and is seldom elongated.



Camptosorus rhizophyllus

5. Persimmon Hollow. About half-way down this Hollow, a meandering little stream finds itself in a narrow, rocky defile, deeply shaded by the heavy forest, with rocky cliffs on each side. Great boulders abound, covered with moss, and lichen, and fern. At the moist, shadiest part of the ravine — the "Gorge," grows this type of Camptosorus. It was rarely found with an attenuated, proliferous basal lobe. Some fronds are figured which were taken from a plant in 1918, and again ten years later from the same plant, which show the rate of growth and development.

Almost all the plants here show a tendency to become more or less pinnatifid.



Camptosorus rhizophyllus

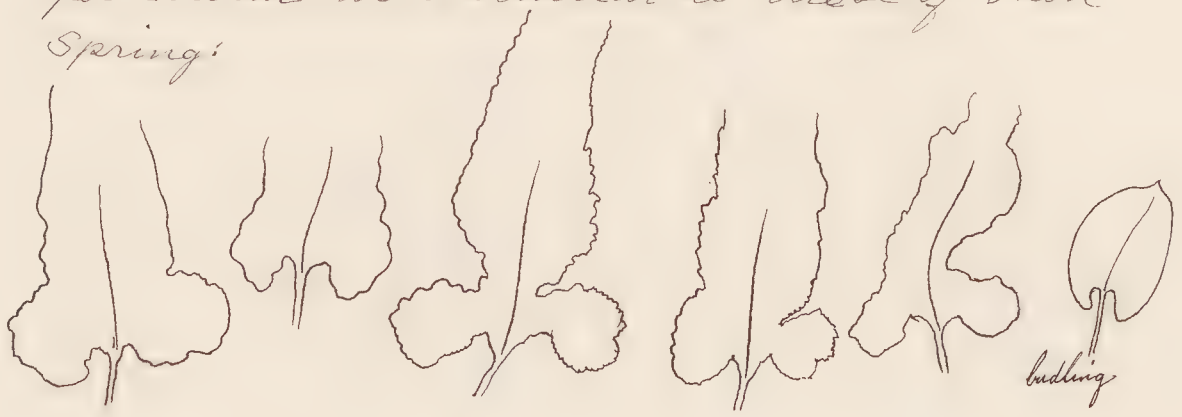


These were all collected from the same plant— A, the largest frond, in September, 1915. The rest in September 1928. From the Gorge, in Persimmon Hollow.

Camptosorus rhizophyllus.

6. *Indian Creek Group.* The walking ferns from the rocky cliffs of Indian Creek near its mouth are long, and deeply lobed at the base two runs have been found that were proliferous. Most of these plants had crisply wavy edges, or were more or less deeply and regularly serrated.

Those collected from the rocks on the upper stream were similar to those of Iron Spring:



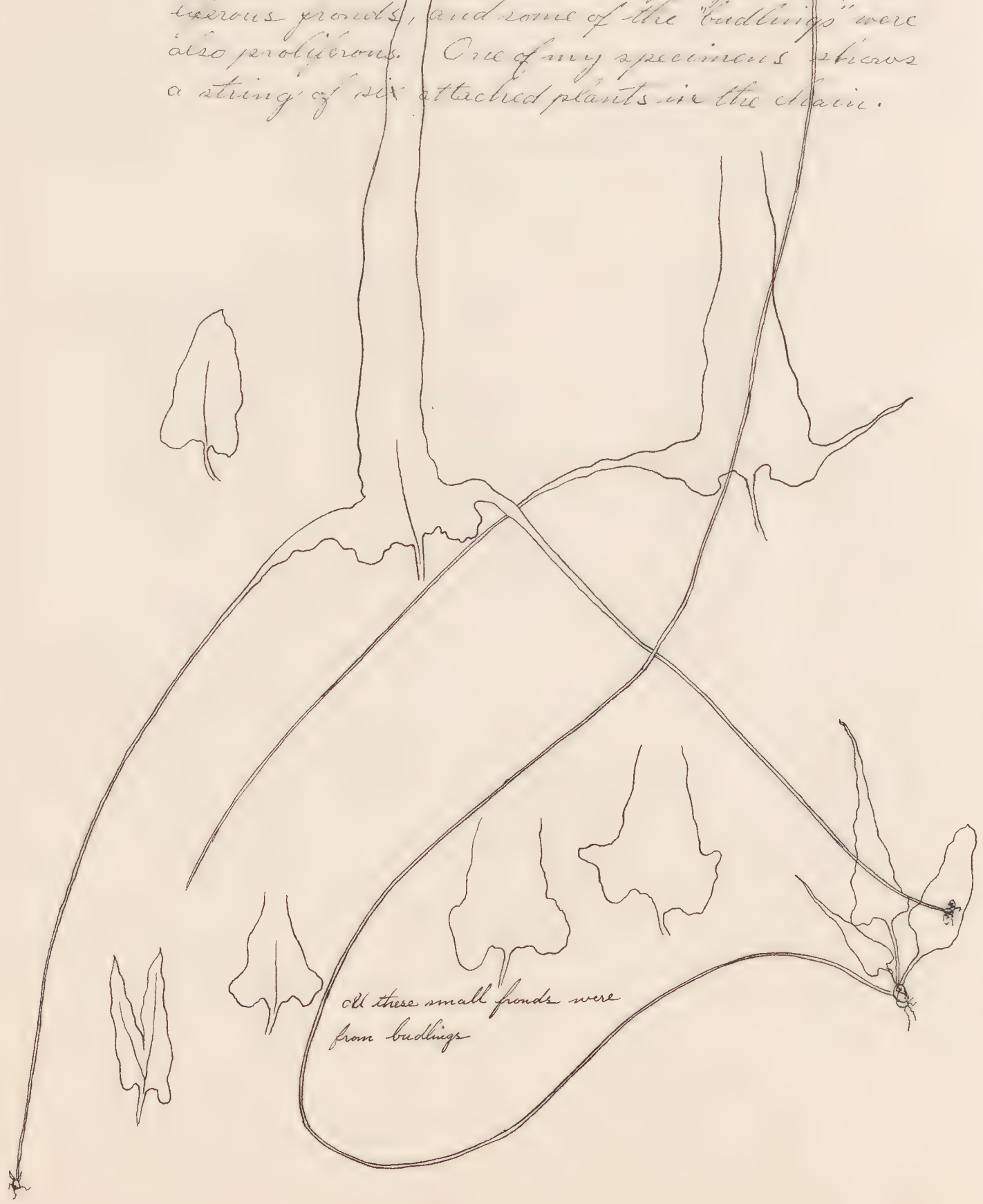
Camptosorus rhizophyllus.

7. Jacques Creek. *Not over four miles long much of the course of this stream is underground. In parts part it is covered with a dense tangle of witchhazel and other shrubs. There are many bluffs and low ledges along its narrow valley The Camptosorus growing on its mossy rocks are generally much frilled, notched, and crisped, and often serrated irregularly. The bases of the fronds are very angular and often deeply lobed.*



Camptosorus rhizophyllus.

8. Fairy Falls Canon. On a great rounder in the older part of this canon grows the most luxuriant and finely developed mass of walking fern I have ever seen. Unusually large, their fertile fronds were often 18 to 20 inches long; nearly always proliferous on one or both sides of the strongly auricled base. One plant had fifty such proliferous fronds, and some of the "budlings" were also prolific. One of my specimens shows a string of six attached plants in the chain.



Cheilanthes lanuginosa Nutt.

The favorite habitat of this fern is on cliffs of a dark grey limestone which has an odor of crude oil on being broken ("stink-rock" it is locally called). Its surfaces have weathered into rounded irregular hollows and crevices and cracks or fissures of all sizes and depths. The gray-green rosettes of these ferns densely fill these pockets. But little moisture from storms can reach them directly, save that which is vaporized in the air. During dry periods the fronds roll up compactly, appearing dead, but become as fresh and green as ever when the air is again moist.

Its preference seems to be almost inaccessible bluffs in the most exposed situations but is also found in the shade of the forest, and is rarely found on separate masses of rock.

It occurs on the James River bluffs 300 feet above the river. These rocks appear again as low cliffs all along Indian Creek facing the West. Those on upper end of the valley are high up on a very steep hill, and is evidently what remains of a great bluff, the talus forming the hill in front of it. The forest on this ridge is noticeably much younger than that about it. Down the slope a ways is an irregular line of great boulders of the same rock which undoubtedly have slipped from the top of the bluff. Some miles further down the cliff re=

appears, but at a much lower elevation. Every pocket and cavity of these rocks is filled with this fern—that is, every exposed cavity. Nothoëna dealbata is often found with it.

Another station is on Jacques Creek, near its mouth, where a low cliff, 5 to 7 feet, skirts the base of a hill for about half a mile. It faces East, in the dense forest, where every cavity had its tenant fern.

The fern has never been found on both sides of creek or ravine, and only on the outer exposed sides of the rock. The other sides often carry many other ferns -- Cystopteris, Pellaeae, Woodsia, Camptosorus, etc.

Transplantings were made to the sides of the home rock next the hill, to the same rock and exposure on the opposite side of the ravine and to crevices of other kinds of rock in both exposed and sheltered situations, to all of which the fern seems to have taken kindly. It did particulary well on a bed of moist sand on my laboratory table for a year.

Plants of Cheilanthes lanuginosa and Nothoëna dealbata were placed in a glass box, and the air kept thoroly moist, no water being permitted to reach the roots. They flourished, remaining fully expanded, and producing new fronds

Cheilanthes lanuginosa.

for nearly a year. Then the air in the box was permitted to become dry, and the roots were given ample moisture. The plants reacted as usual in dry weather — the fronds rolling up and a resting condition setting in. When the air was again moistened, growth proceeded as at first.



Cystopteris n.sp. Prince.

This plant has very much the same appearance as C. fragilis in texture, coloring and cutting, but is noticeably different in its much larger size, its drooping or pendulous habit, and the form of its fronds which vary from broadly triangular to triangular-ovate. It seems to be confined to moist, mossy rocks and ledges in deep forest shade, and is not rare

The broad triangular lower pinnae and triangular indusia are marked characteristics.

In its usual habitats it had never produced bulbils, and remained a puzzle from 1893 to 1923. Transplanted to my fern garden at Manhattan Kansas in the latter year, it did well, tho a much smaller than before removal. In 1926-27, the fronds produced bulbils on their backs.

These bulbils differ greatly from the common species both in their form and in their method of attachment. (The ordinary form does not grow in South Missouri. This whole plant differs widely in every particular.) They are long and slender, have a distinct pedicel, and bear numerous long, slender, lanceolate green scales, which are rather crowded toward the apex. They are attached directly with the vascular bundles and do not separate readily as do those of the common form.

Cystopteris n.sp.

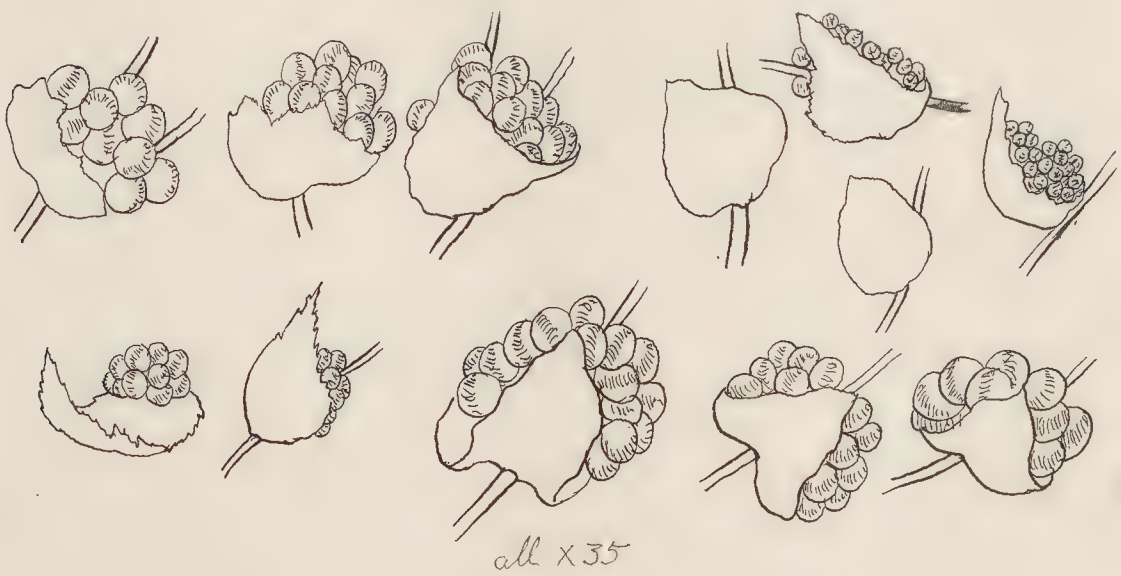


Cystopteris fragilis Bernh. Fragile Bladder Fern.

When I came to study this fern I found that it merited Bertiardi's description which just about covers everything a fern could be in the way of being different and yet be it. There are so many differences one is tempted to divide the collection into as many ~~species~~ as he has specimens, and finds it difficult to limit them to the recognized five varieties.

One from the Shelton ravine is 3½' wide—15-16' long, pinnae narrow, distant; pinnules very narrow, cut to the rachis, distant; pinnae opposite and horizontal, finely cut—a beautiful plant—a variety only by its inclusion. Some others are deltoid, 3½'x4½ inches, others longer, with broad bases; and there are others with the lowest pinnae more or less reduced, in some, set forward at an angle.

Transplanting had little or no effect on these ferns; they take kindly to the garden or even to house culture.



all x35

Cystopteris fragilis



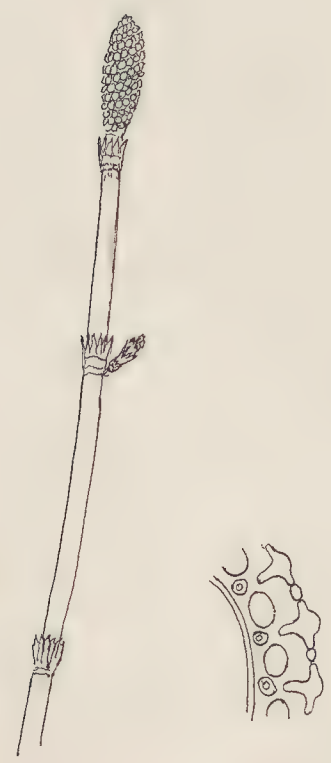
Equisetum arvense L. Horse tail.

Very rare. Growing in the bottom of a shady ravine, just off of Indian Creek



Equisetum hyemale L. Scouring Rush.

In the north end of Jacques Creek, and near Iron Springs.



Notholæna dealbata Kunze. Whitened Cloak fern.

This fern is far less common than Cheilanthes lanuginosa whose habitat it shares, and many of whose peculiarities it shows. It is more intolerant of wet, and of shade, and more exacting as to exposure and inaccessibility. It was always included in experiments with Cheilanthes and a full account will be found under that title.

All attempts to establish it in the fern-garden failed, tho it did well in the moist chamber.

When dry conditions prevail the opposite pinnae approach each other face to face, tending to roll up together; when the air becomes damp again the whole plant expands, and resumes growth.

The roots are fine, copious, their area fully equalling the frond area.



Onoclea sensibilis L. Sensitive Fern.

In September, 1893, a small plant was found stranded on a stony islet in the James River, near Galena. Nowhere on that river, or in the territory south of it could any trace of that fern be found.

It was planted in the fern garden just below a spring, on the limestone rock which forms the bottom of the ravine. A thin stream of water has never ceased to flow over this rock.

The plant has grown very large and covered the bottom of the ravine, a space of about 8 feet by 15 feet. The later fronds are progressively larger and their cutting deeper, the fertile frond more loosely wrapped and compressed.

It has not spread, nor been found anywhere else.

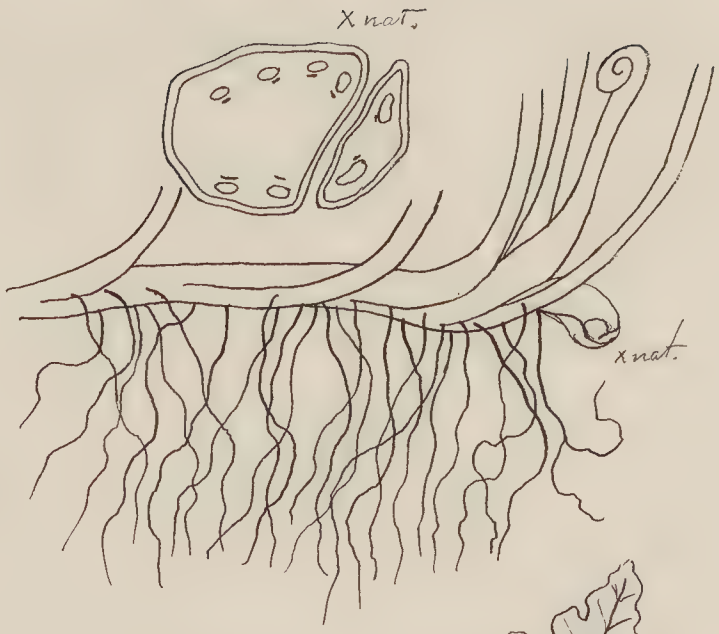
In 1928 rhizomes were taken to Manhattan, Kansas, where it has been growing ever since, tho much smaller than before being removed.

For many years before removing to the Ozarks, I had been studying this fern, raising it from spores etc, and include those studies as part of this account.

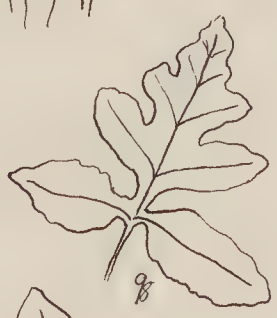
Observations of the variety <u>obtusilobata</u> indicate that it is a mere form, often consisting of a single frond, induced by some factor unknown

Onoclea sensibilis





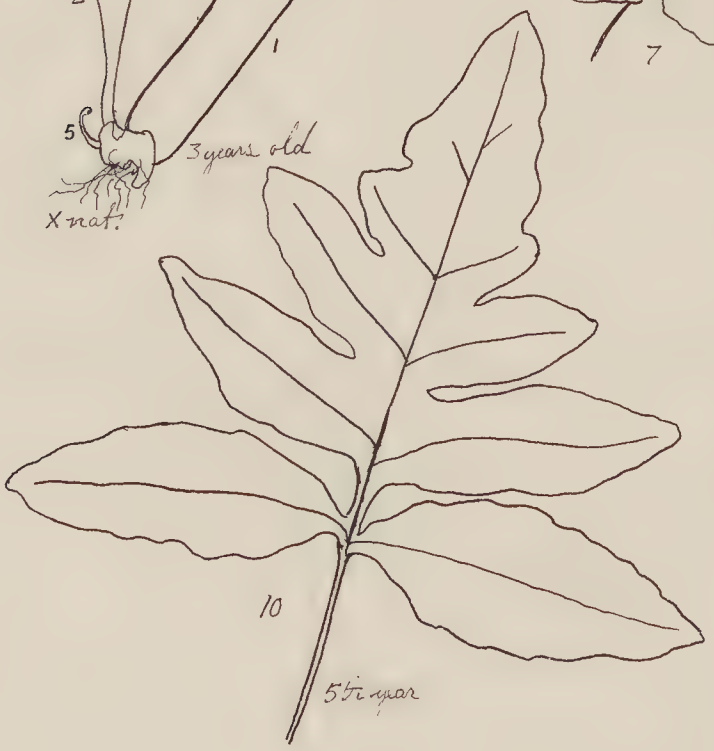


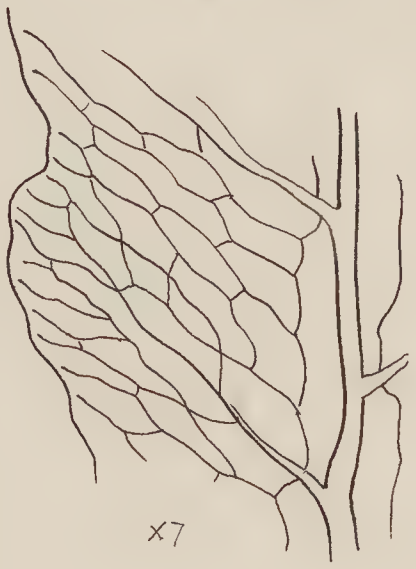




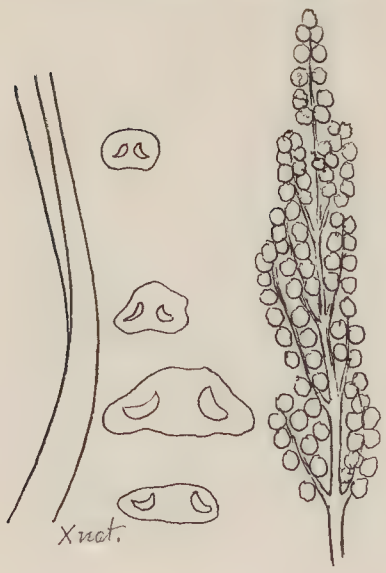








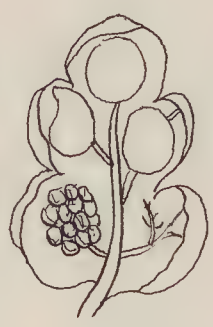
Onoclea sensibilis



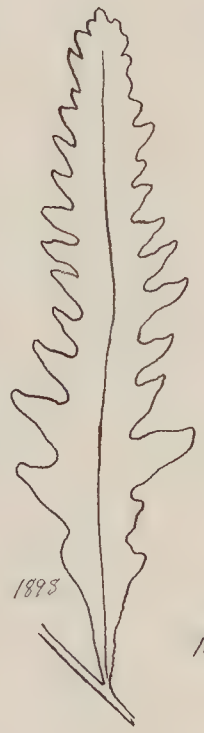


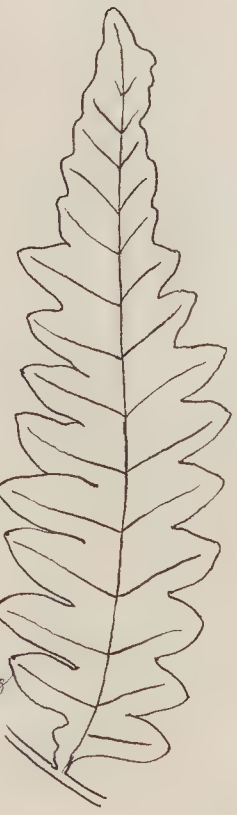


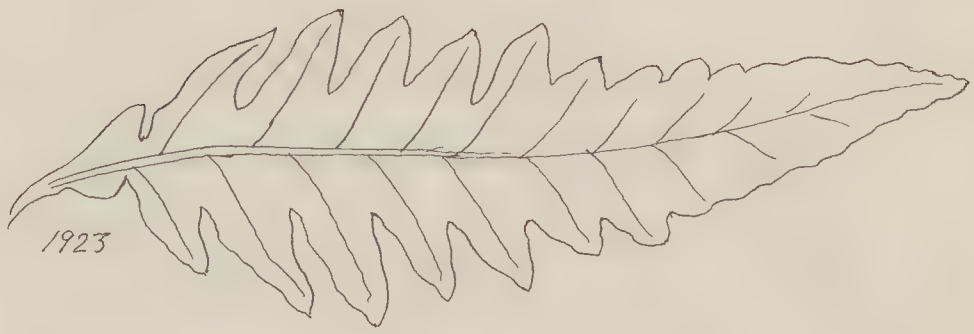














1924. From the <Camptosorus> plant. There were many fronds twice as large.

Ophioglossum Engelmannii Prantl. Adders'tongue.

While several of our ferns are suspected of taking long naps and of disappearing from their usual haunts for a longer or shorter season, the Ophioglossums are notorious in this respect. They are also celebrated for the unexpectedness with which they may appear in localities where they have not been seen before.

Altho a vigilant outlook had been kept for it in my district, since 1895, it was not until 1915 that the first were found. These were in the path to a spring, in daily use, and there were but few of them.

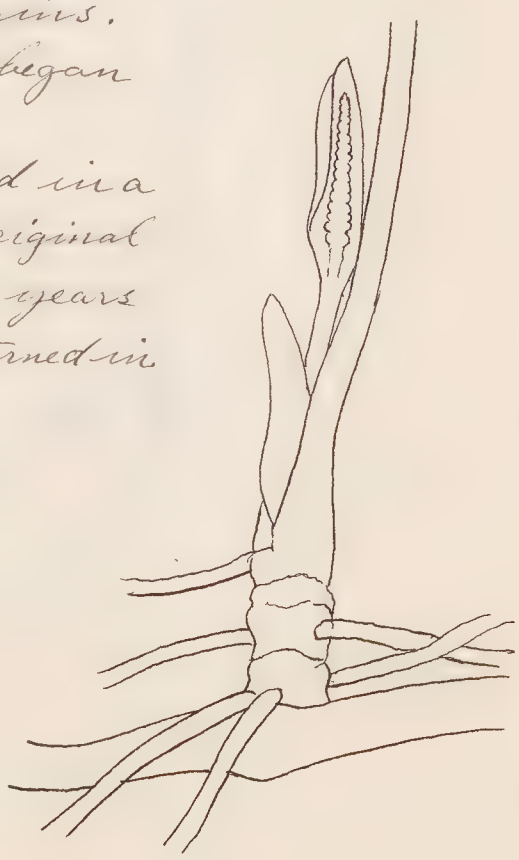
In 1916 three other groups were found, not far from the first location, which, also, sent up fronds. Later, another colony was found, half a mile away.

In 1917 colonies of different sizes, some with hundreds of plants, could be found almost wherever looked for within a half-mile radius.

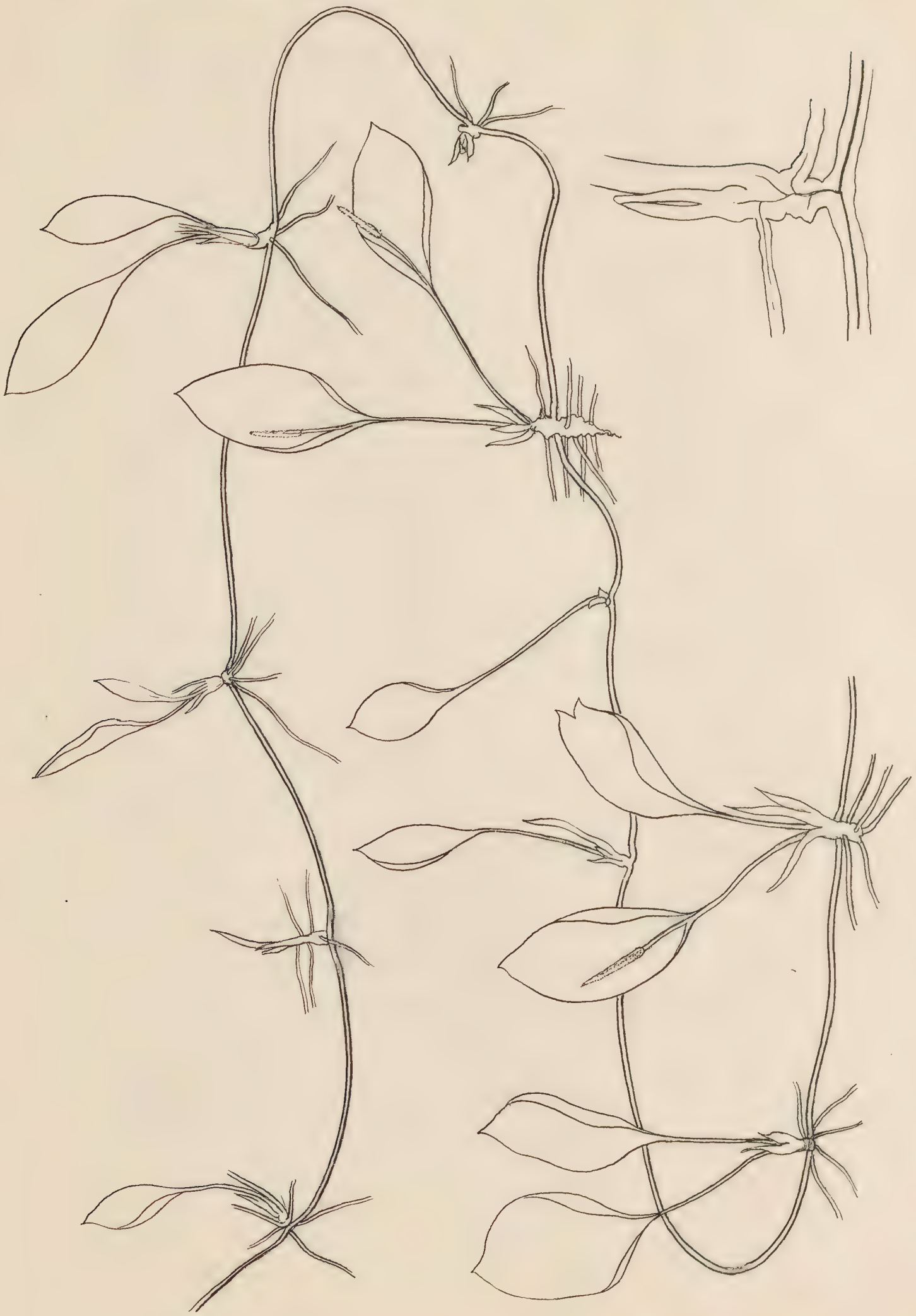
While April, May, June, seemed to be the time of its most general appearance, it was found every month in the year, after heavy rains.

In October 1930 a general reappearance began in the Persimmon Bald station

In September 1925 a colony appeared in a side hill road four miles north of the original find and reappeared for four successive years when the land was fenced and goats turned in



Ophioglossum Engelmannii



Ophioglossum Engelmannii.

In April, 1931, the glades on the West slope of Wolf Ridge, four miles North of the original locality, and the adjacent bottom of Indian Creek showed hundreds of the plants

Taking advantage of several days of heavy rains, I succeeded in digging out a small colony without breaking the stolon. There were, altogether, forty-three plants on the stolon, in all stages of development, from mere swellings, or enlargements of the slender stolon, to old plants several inches long. It seems as tho the stolon had first produced a distant plant, and later, at intervals, others in between, in no very regular order or sequence. The new plants were always seated on the stolon; growing both ways they formed their vertical rhizome both above and below the stolon.

These plants had their fronds in pairs; both might be sterile, both fertile, or one sterile the other fertile in which case the sterile would be would be the oldest of the pair — that is, would precede the fertile on the common axis.

Seldom was the stolon branched.

As in Botrychium several years are required to perfect its fronds. ~~The~~ A sequence ~~of fronds~~ sent above ground becomes exhausted, the plant has to prepare another set, and "disappears" for a time. When this happens to all the units of the colony at the same time, the whole colony disappears.

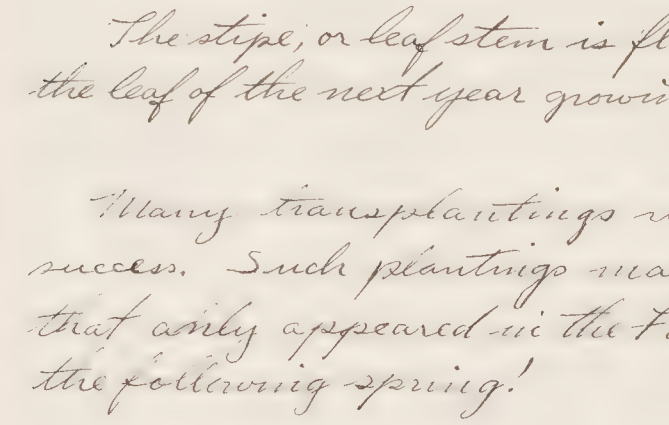
Ophioglossum Engelmannii

It would appear that the stolons function as a more or less permanent rhizome or axis of growth, giving rise to the various leafy outgrowths, some of which may develop into independent plants and produce other stolons

The stipe, or leaf stem is flattened at the base the leaf of the next year growing up beside it.

Many transplantings were made with success. Such plantings made from groups that only appeared in the Fall, sent up fronds the following spring.

In the Wolf Ridge – Indian Creek colonies, there were comparatively few fertile fronds. In all the other colonies, except the reappearance Persimmon Bald, a very large proportion of fronds were fertile; the later Persimmon Bald plants were small and mostly sterile.





Pellæa atropurpurea Link. Purple Cliff brake.

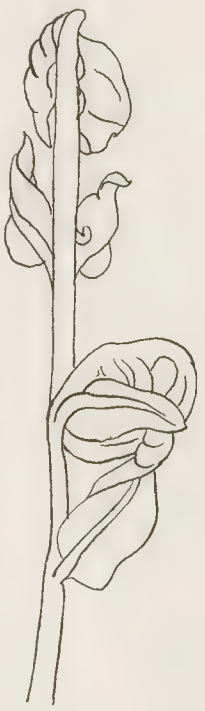
The most common fern in the country, growing everywhere, seldom in dry exposed situations, but preferring, and at its best in crevices of limestone rocks in moist, shady places.

The fertile fronds appear at a very early period in the life of the plant, differing little from the sterile in appearance, the later ones becoming successively more and more like the type as the plants grow older.

This would account in part for the great variation which is shown by this fern in this region. And even moisture, exposure, light and shade, soil; all these fail — so I think the reason lies in the plants themselves.

Each pinnule is articulated to its stalk and falls separately when the spores ripen, the stipes remaining for a long time, breaking up gradually.

Stipes, rachises and rachillas densely covered with stiff whitish hairs; those on young fronds long and softer



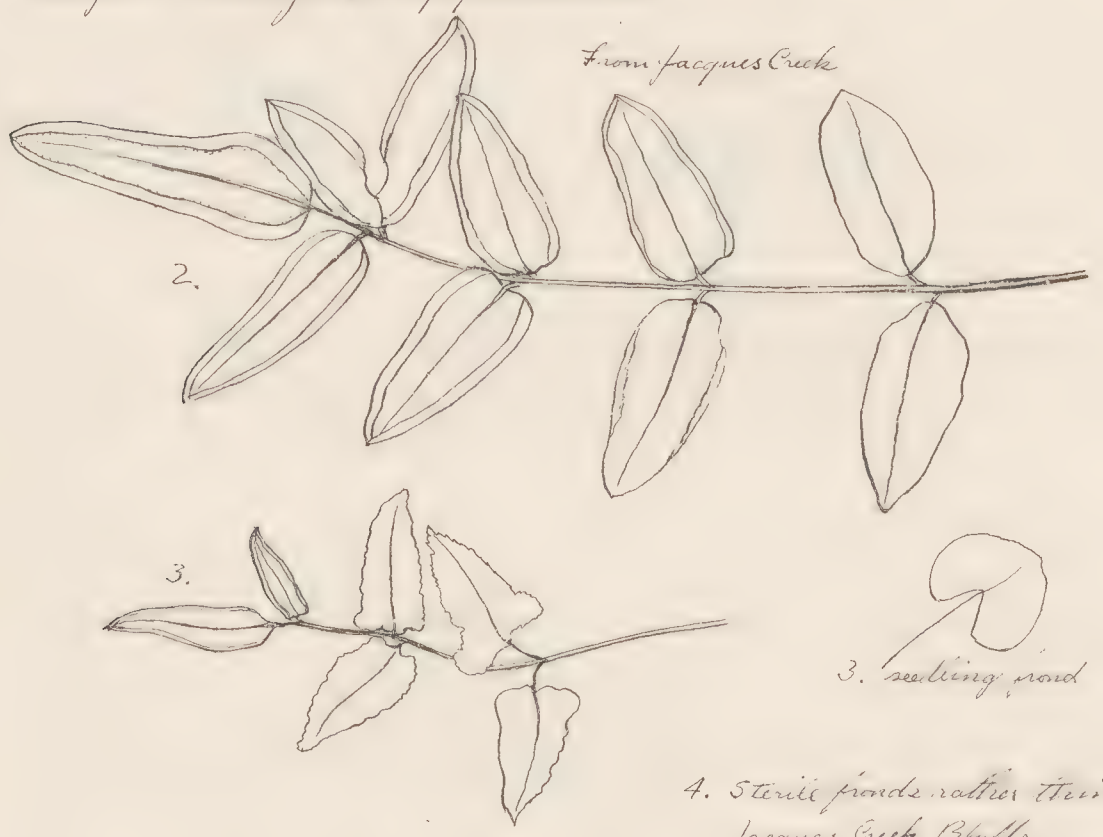




Plants growing at the fern garden, 1915, pinnules closely placed, edges crinkled, broadly oval in shape. A not uncommon form.

Pellæa atropurpurea

The greater number of the plants we find are simply pinnate, many of them showing little if any differentiation between the sterile and the fertile fronds; texture is thin, veins quite visible; bases of pinnules abrupt or squared, giving a triangular appearance.



3. seedling frond

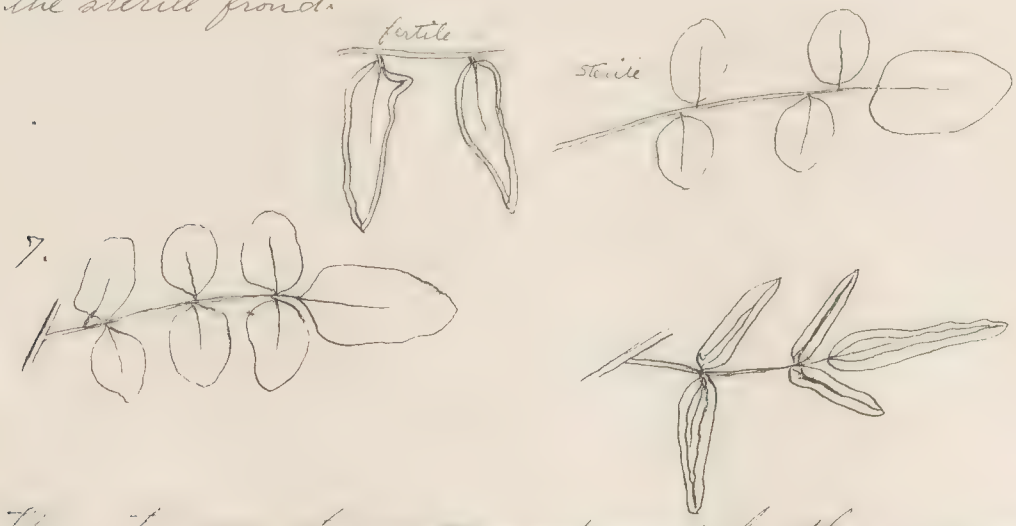
4. Sterile fronds rather thin, Jacques Creek Bluffs.





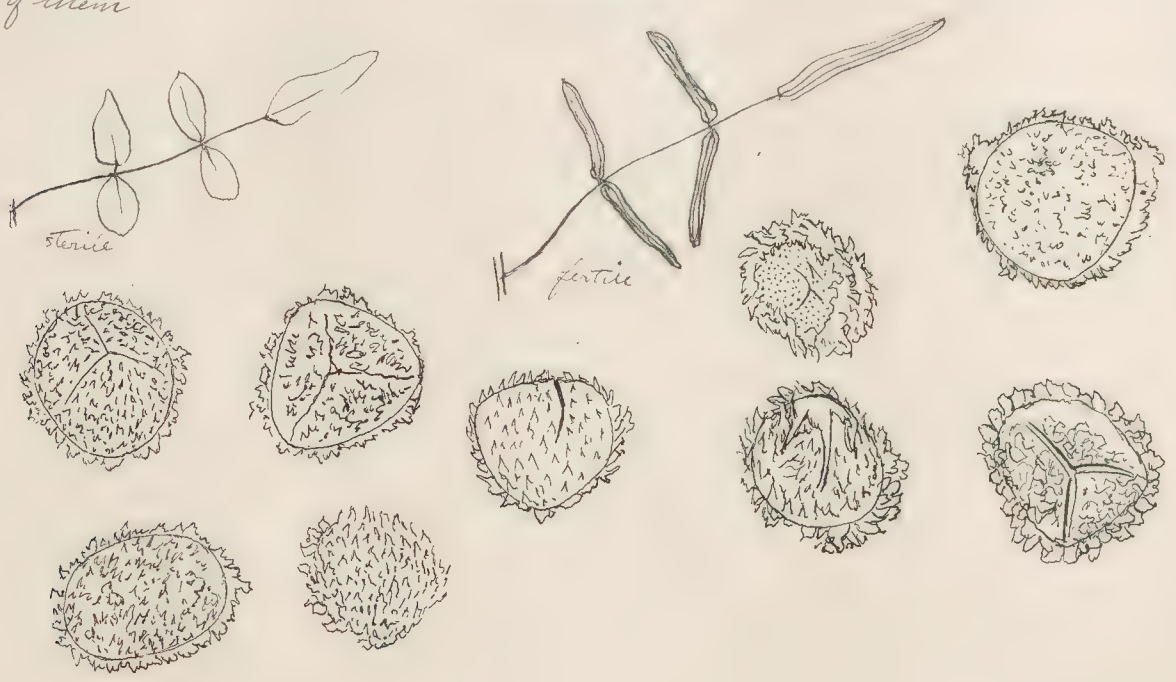
Pellaea atropurpurea.

5- Pinnules and sometimes pinnae deciduous; the lower two or more pairs pinnules on fertile frond, sterile and much like the sterile frond.



These two seem to ~~average and general~~ be the average and general types, of those with bipinnate fronds.

A form that is found occasionally; fronds often 15-16 inches long; growing in dense clusters; pinnae distant, long stalked, distance between radius and first pair of pinnules greater than between first and second pair pinnae; ultimate pinnule long-stalked, a skeleton-looking frond, ~~8 inches long~~; there are sometimes 30 of them



Pellaea trifolidta n.s. Small Cliff brake.

This little fern resembles a a small, undersized atropurpurea at first glance, but is so radically different in habits and habitat; in its development from the spore to maturity; in the form of its fronds; its vascular bundles and even in its spores, that I think it must be considered as a different species.

It grows in densely crowded lines in horizontal crevices of limestone rocks on the face of steep cliffs and bluffs, in very exposed situations.

It was first found in 1895 on the bluffs of James River, opposite Galena, and was under constant observation and study until August, 1926, when a section of the bluff 15 feet thick was blown off to make place for a road. It was, found in two other places on Jacques Creek.

Plants of atropurpurea of similar size and appearance were selected for observation and comparison.

While these latter plants grew larger and developed into the mature atropurpurea form trifoliata maintained its characteristics to the last observation and check.

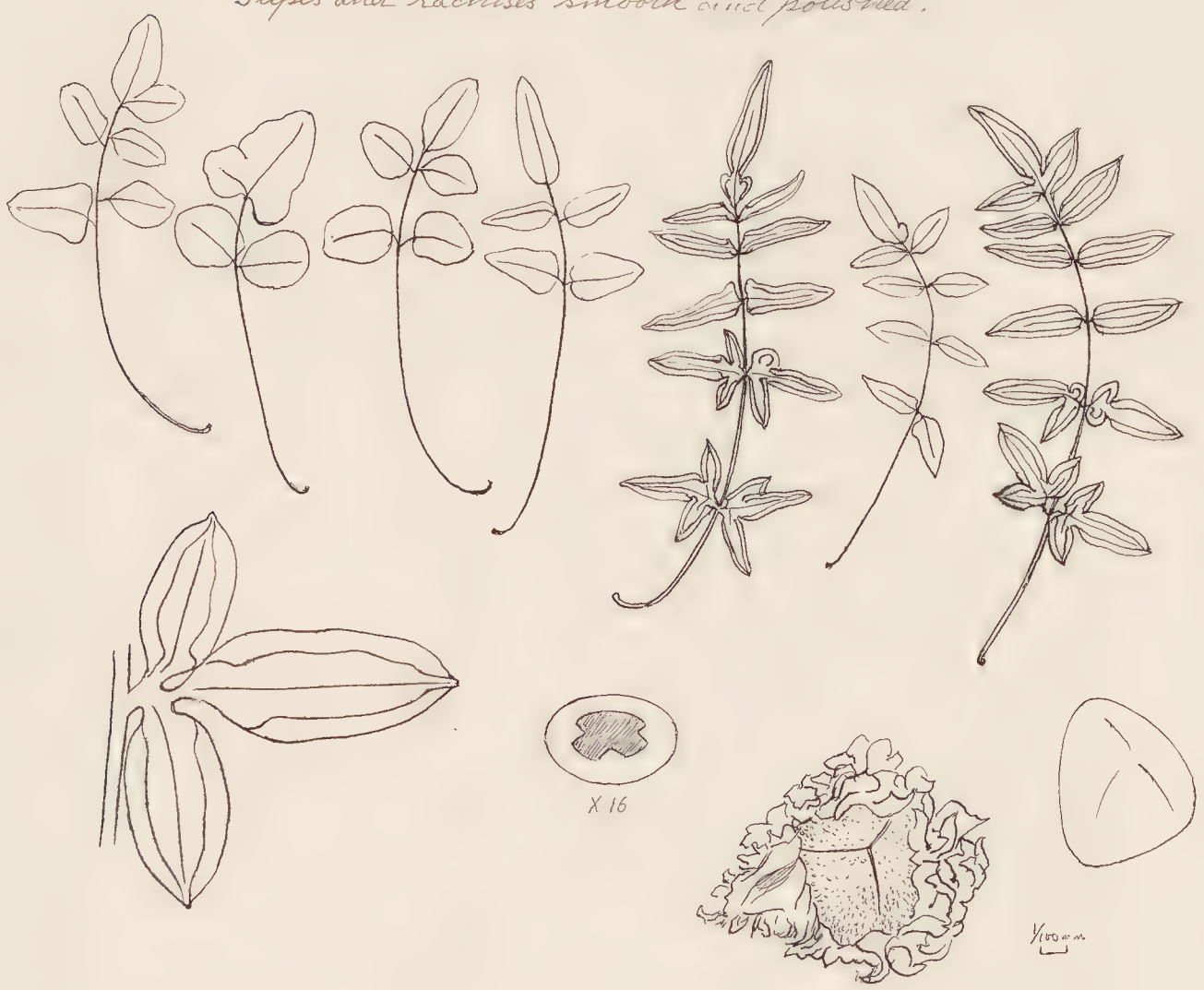
Pellaea trifoliata n.s.

Rhizome short, thick, densely covered with light brown scales of all sizes intermixed, hair-like to .5mm wide by 7mm long, tapering to a long slender point at the apex, and slightly toward the base, from below the middle; without midnerve; stipes densely tufted, in a crown, dark cinnamon brown, polished, smooth, with only a few hairs near the base, oval, slightly flattened in front, wiry, tough, persistent, 15mm to 25mm long, slightly dilated at the base; fibro-vascular bundle solitary, roundish or oval, with a broad V-shaped furrow on the anterior side and a small V-shaped furrow on each side; sterile fronds rare, thin, bright green, 25mm to 35mm long, simply pinnate, ovoid; the pinnae oval to obovate, 3-4 pairs, 8mm to 10mm long; distinctly stalked, the apical one obovate to triangular-ovate, deeply lobed on one side; margins very narrowly cartilaginous, crinkled, slightly curving back, veins plainly visible; stipes 30mm to 40mm long; fertile fronds 35mm to 120mm. 20mm to 32mm, wide, narrowly ovate-lanceolate pinnate; pinnae 5 to 8 pairs, opposite; very short-stalked, distant below, more and more crowded above, lowest pair smaller, not deflexed, horizontal, all but the upper 3 to five pairs deeply trilobed, deep green above, paler beneath, smooth, thick, rather leathery, deciduous; segments ovoid to narrow-oblong, upper basal one usually smallest, the middle segment very much the longest, mucronate; veins immersed and obscure on the upper side, very visible below; involucre

Pellaea trifoliata n.sp.

broad, formed by the curving backwards of the segment, the very edge cartilaginous, thin, crinkled; spores round-triangular, trivittate, covered with very fine scales; enveloped in a sort of husk.

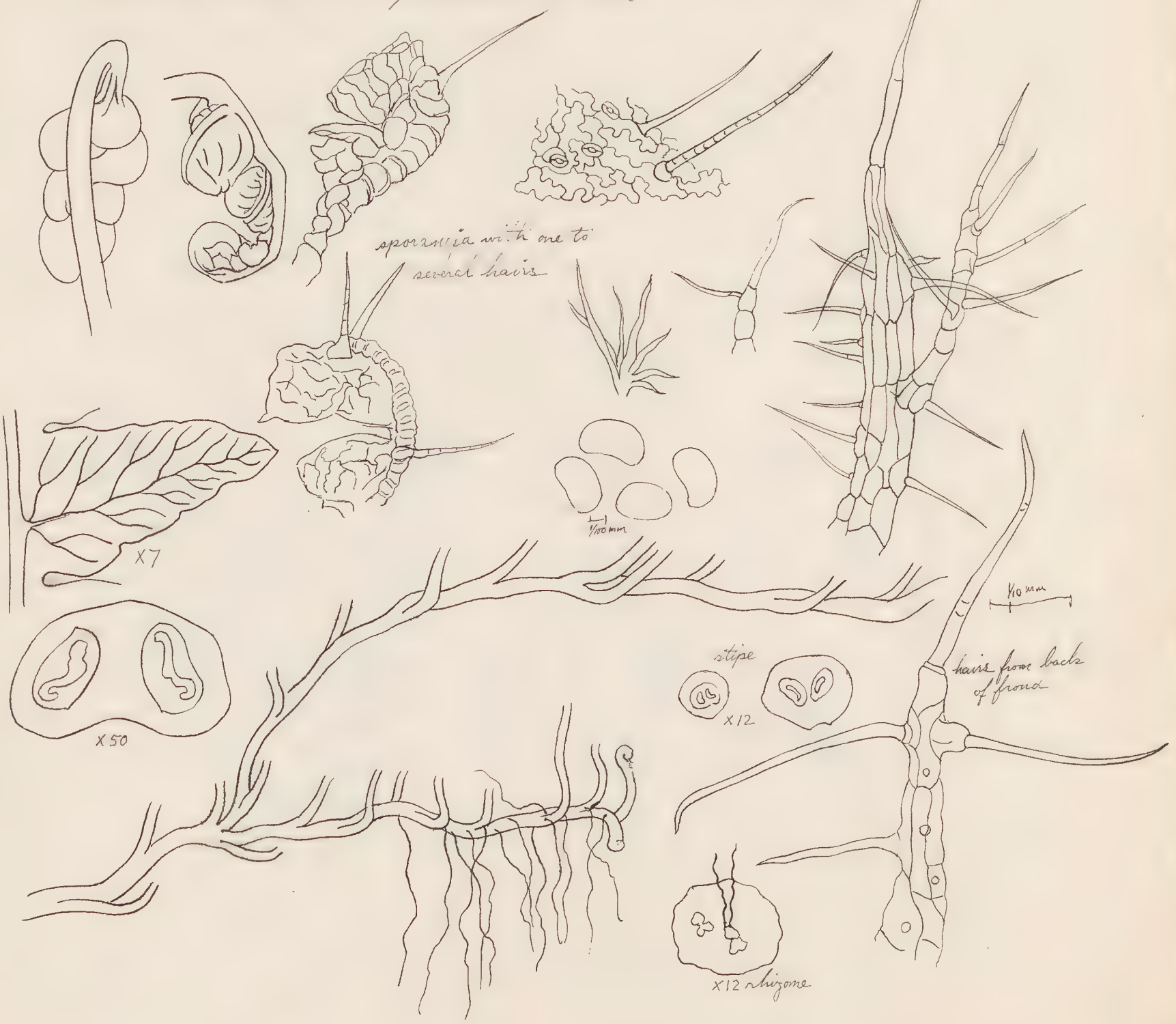
Does not roll up when dry.
Stipes and rachises smooth and polished.



Phegopteris hexagonopteris

Growing vigorously in such ravines as are protected from fire, cattle and swine, the broad Beech fern is really rare. The finest colony is in the upper part of Pinery Hollow, not far from Marvel Cave, in a copsice of Hazel, Spice bush, etc.

They transplant well to places similar in light to the habitat. Rooted in the soil, that also is an important matter.



Polypodium incanum

Deep down in the "Gorge" of Persimmon Hollow the top of a great block of stone, with lichens and mosses in its cracks and crevices, formed an ideal home for the tiny plants of the Gray Polypody found growing there in 1917. A year later it had greatly increased in size and it is sparsely soriferous.

In September 1923 they bore all the marks of maturity, and had well covered the top of the boulder (7X9 feet) and some of the crevices in its sides. One branch had coiled several inches up the stem of a small shrub.

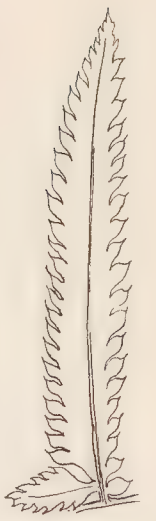
In January 1931 the rock was densely covered with the fern.

Transplanted to the rocks in Marvel Cave Fern Glen it has held its own.

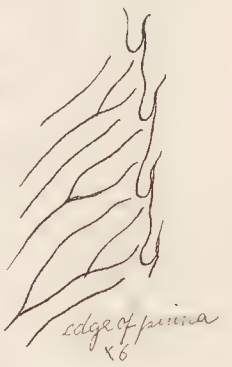
The nearest station seems to be fifteen or twenty miles south in Arkansas.



Polystichum acrostichoides
Polystichum acrostichoides incisum (A. Gray) Undw.

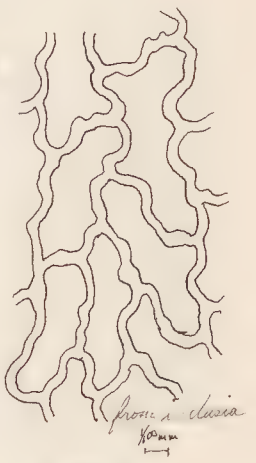


From 1893 to 1896 the variety was the most common fern in southern Missouri, the species apparently being very rare. Since 1897 rarely could a frond of the variety be found, the plants bearing only fronds of the ~~species~~ type. These leaves being truly evergreen, and very slowly recurving and becoming prostrate afforded a ready means of comparison extending over several years. Many of the groups and plants had been marked for observation, and records made.



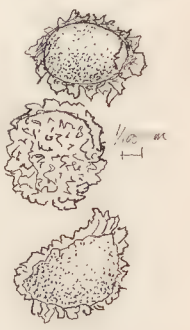
These plants grew in rather dry situations on sloping banks, or in broad, gently sloping hollows, in not too shady woods, and often in very large numbers. They often bore as many as 20 to 30 fronds.

They were easy to transplant and thrived wherever planted, whether in the garden, or in the parlor fern basket, asking little care and little moisture.



All specimens of the incised forms produced only uncut pinnae after being transplanted.

There was no cessation of growth in these plants at any time; there was always a new frond outgrowing, and another curving over still more to join the arching ring which surrounded every plant.





Polystichum acrostichoides



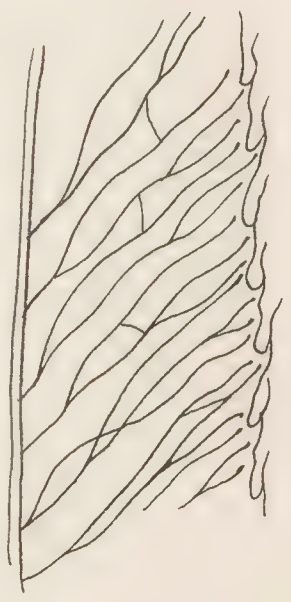
Polystichum acrostichoides.
Polystichum acrostichoides incisum.

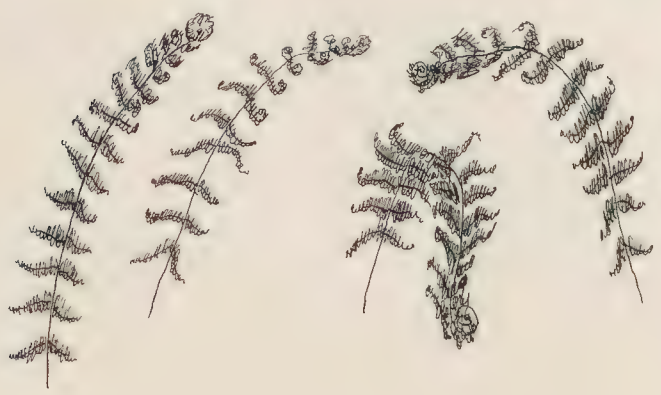
In 1923 there were few plants with either the normal or the incised fronds. All seemed incisum gone wild! Of all the mad freaks that ever broke loose here was the maddest!+ Wildly, extravagantly variegated in cutting, in form, in division! and every plant had its old leaves to prove that it had been as staid and demure as a well behaved fern-plant should be.

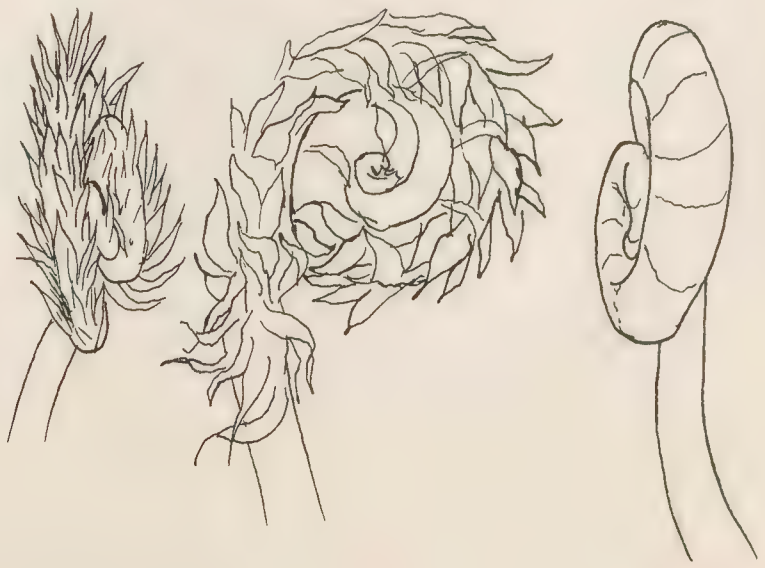
In many plants most of the pinnae ended abruptly at a half or less than their usual length, while here and there was a much longer one. Often the lower pinnae on both sides were shortened, the upper ones remaining long. Often one side of the pinna would end abruptly while the other coiled spirally upward like a snail shell to form a little green funnel or cornucopia. In some the blades were scarcely at all cut. In others, the pinnae were a wild confusion of slashes. In some, the fertile fronds were broad and leafy all the way to the top, and the sterile fronds were narrowly contracted; some were like a string of green buttons. By 1925+ these plants had all returned to normal again.



In 1931 many plants are showing one-to-several more or less deeply cut and variant fronds.+ There seems to be an alternation of normal and variant seasons, very irregular in their recurrence.







The Bracken — Pteris aquilina
Pteris caudata

Previous to 1898 the Eagle Fern or Bracken was a very rare fern in the southeastern part of Stone County; there being but two stations known. These were both typical aquilina.

From 1902 with the thinning of the forest for railroad timber, the fern began to increase rapidly, and since 1926 has appeared in great numbers, not only at the edges of cleared land throughout the now thin woodlands and threatens to become as great a weed here as it is in many other places.

The suddenness with which it appears and disappears en masse is not equalled even by the Adderstongue.

In 1918, a community of 100 fully mature fronds, 2 to 3 feet high appeared in the deep woods where there had been no signs of ferns before. In 1923 the number of fronds had greatly increased, tho the area occupied remained the same. In 1926 there remained not a trace of them.

For the first time, in 1923, the upper part of the Thomas Ravine was filled with a dense growth of the fern, which had never been observed there before. In 1931, the area occupied had not been extended

In 1925 the fern appeared in a thin woods a quarter of a mile away, taking absolute

possession of an area several acres in extent. In 1930 the area was much reduced, the fronds much smaller. The rhizomes were not over two inches deep in the very compact, stony soil, and often were even on top, and very much flattened and distorted. On one edge of the area, where the soil was loose, deep, and mellow, the fronds were 3 to 4 feet high, and the rhizomes very large.

caudata. In 1898, two years after a new road had been opened thru the forest, there appeared a heavy bank of Pteris fronds, 3 to 4 feet high, of a brighter green than usual, the end segments being very long and slender, and in other respects differing from aquilina and answering to caudata. The growth, 5 feet by 100 feet, has since been destroyed. No other station for it has since been found in this district.

The rhizome of these two Pteris may reach a length of 10 feet, or even more, there being a method of cutting off the branches much sooner than the progress of the dying zone would do, and so conserving the energies for main stem growth. The fronds are arranged spirally, right over to left, in four ranks, rather distantly, becoming closer towards a branch which is formed at quite regular

intervals, alternately each side, the first leaf of which is at the point of forking. Just beyond this first leaf in caudata, the second leaf in aquilina, a deep constriction is formed on some of the branches which weaken them at that place. This part of the branch becomes very dark-colored, like the bases of the stipes, and a dying zone for that branch is set up, which, after a while completes the separation. There seems to be no special order in this - it may happen to the last branch close to the growing end of the rhizoma, skipping some of the earlier branches.

The early fronds are always sterile, whether on main stem or branches, and may equal in size the fertile fronds, which are produced later toward the heated term.

It requires 2 to 3 years to produce a frond mature enough to be sent above the ground, and even then it is not completely formed, further growth being accomplished as it unrolls by the apical cells.

On each leafstalk (apparently) near its base, there is a small protuberance which is thought by some writers to be a dormant leaf-bud, destined to form a new leaf in case of injury to the first.

A horizontal section on the line of the

fibro-vascular bundles shows it to be a branch of the rhizome and continuous with it, its parenchyma fusing with that of the leaf-stalk for a little ways, its origin at the same point.

Some of these "branch-buds" continue their growth and become branches, producing fronds equally mature as the main stem; or they may remain dormant indefinitely; or may grow in length underground, preparing for appearance above ground. The large fleshy rhizome may act as a storehouse for food supplies, and which may explain the ability of the plant to "hide out" for long periods and to make such dramatic reap-pearances.

The xylem vessels which form the outer circle of the vascular bundle, and the two central bundles all anastomose to form a sheath enclosing the other vessels within the bundle.

In aquilina there are a large number of small black cells of various lengths, and taper at both ends. They are scattered without special order throughout the parenchyma of the rhizoma. There are comparatively few of these cells in candata.

The outer coat of the rhizoma is black- in aquilina, there is a very narrow, broken

line of tawney, cork-like, or bark-like tissue along the angle on each side of the rhizome.

In caudata the rhizoma is black, with a very broad band of of the tawney bark-like tissue on each side, extending up the leaf-stalks as far as the darkened area. It also covers such roots as emerge thru its substance.

The anastomosis of the vasculars is far more advanced than in aquilina, so that cross-sections of the rhizome may show them as an unbroken shield shaped figure

The interval between the leaves is much closer, and the leaves more numerous than in aquilina, and their texture more delicate.

The rhizome is more rounded, in young roots decidedly oval.

A noticeable feature is the clustering of the leaves near the ends of the branches.

In aquilina this is not so apparent and the leaves are so widely separated as to appear to be alternately arranged on the stem

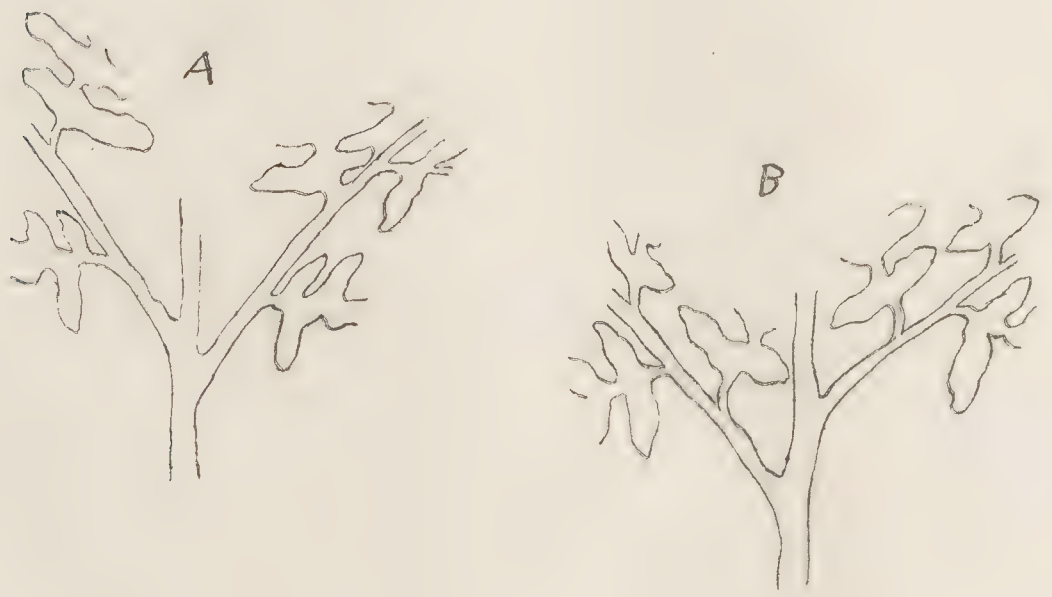
In both Pteris the frond is called "ternate," because of the greatly enlarged basal pinnae.

It is seldom, however, that the points of origin of the two are either opposite or coincident.

The Bracken.

Very often they are widely separated. Usually the pinna on the right-side is the lowest of the pair, but occasionally the lowest occurs on the left, all the other pinnae following this order.

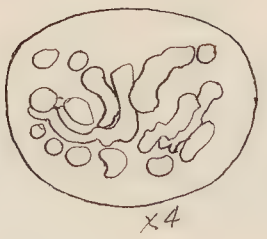
When the lowest pinna is on the right, (A) the first pinnule on its lower side is near the rachis; ~~while~~ (B) the first pinnule on the upper side is nearest the rachis when the lowest pinna are on the left, and this order holds good for all the pinnae on the frond.



Pteris aquilina.

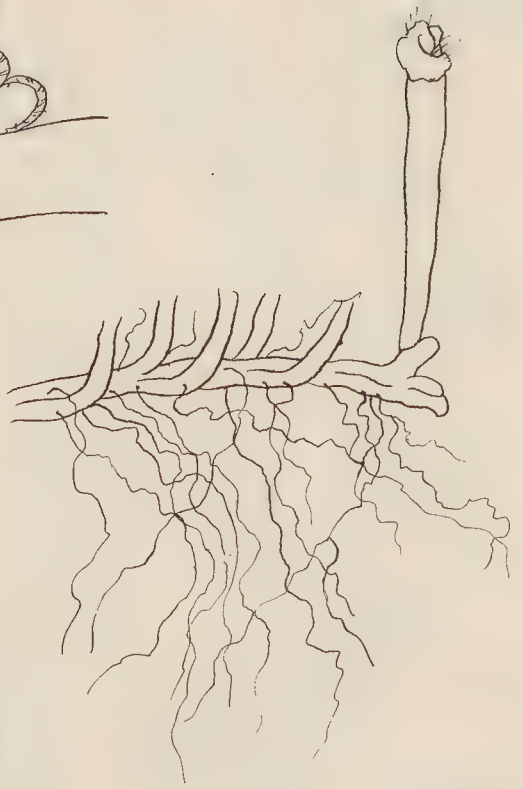


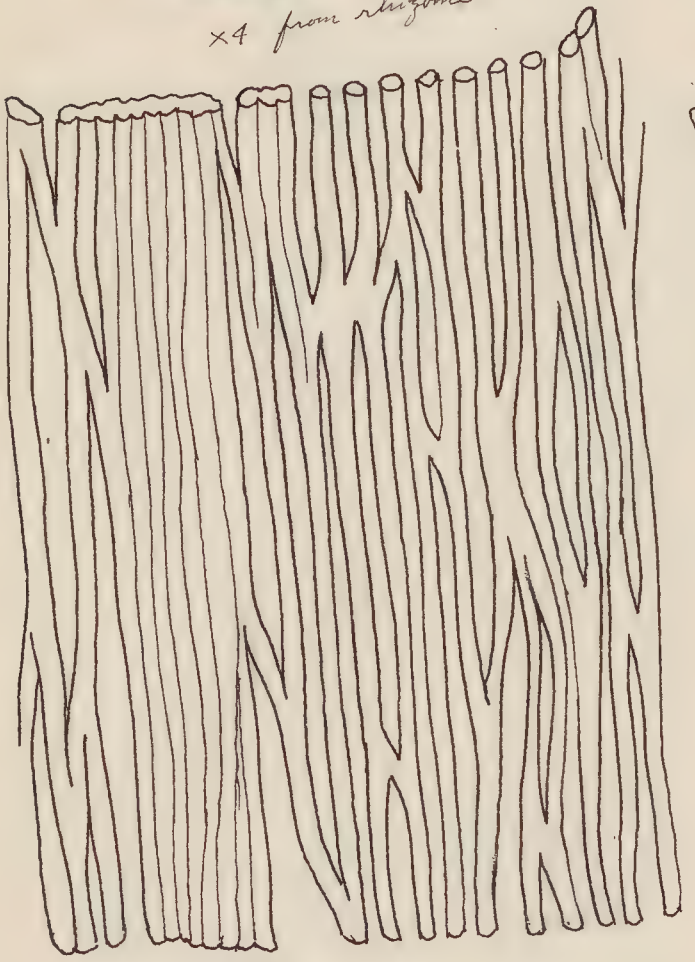
×4 from rhizome



×4

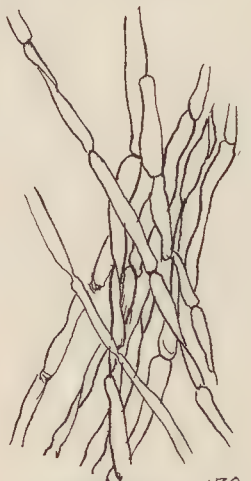




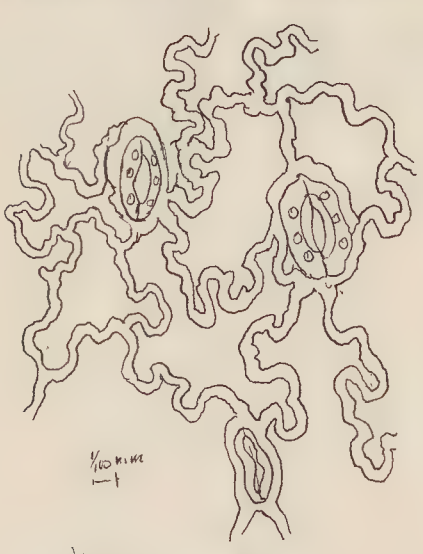




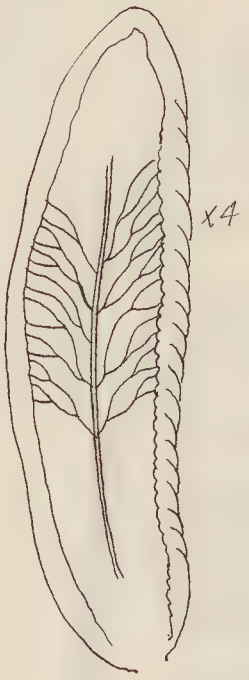
×4



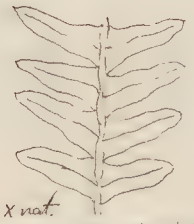
Tomentum X 130



1/100 mm

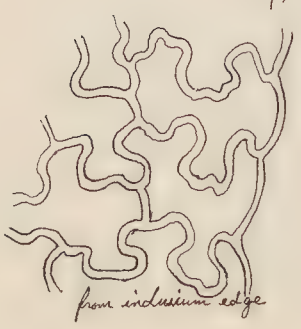


×4



× nat.

Rachis much contracted at junctions with midvein



from indusium edge

Pteris caudata.





Woodsia obtusa Torrey.

At its best it grows in moist, shady places, in clefts of limestone rocks, on mossy rocks and ledges close to springs; under logs or railfences in damp places, often in company with the Bladder ferns.
It is sometimes found in dry exposed places when its appearance becomes quite different.

A large group was growing on top of Shelton's Bluff among limestone fragments, exposed to the direct sun. The fronds were short and crisp, and every stipe had a twist which turned the blade part way round. It had every appearance of being a different fern from those of the fence row which ~~were~~ had long, slender delicate, finely cut foliage.

Transplanted to the Kansas fern garden, in four years they became nearly identical with those transplanted from the fence row at the same time, and which also became somewhat modified. The twist and the crispness was nearly gone. In the others the fronds became shorter and the texture much firmer



Woodsia obtusa



Pteridophyta of the United States and Canada, collected 1873–1930, with notes and drawings; exclusive of those of "Camptosorus."

List of the Pteridophyta

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1873–1930

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" goldianum ~~253~~ 158
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" simulatum ~~265~~ 164
" spinulosum ~~267~~ 165
" " dilatatum ~~267~~ 165
" " intermedium ~~267~~ 165
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" fendleri ~~273~~ 168
" parryi ~~273~~ 168
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" " obtusilobata ~~275~~ 169
" struthiopteris ~~275~~ 170

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" " incisum ~~293~~ 178

" munitum inciso-serratum ~~295~~ 179

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Pteris aquilina ~~177 to 189, 297~~ 180

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Selaginella apus ~~299~~ 181

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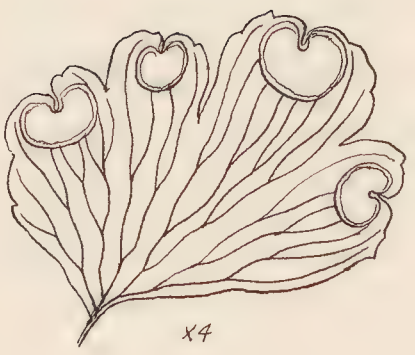
Woodwardia areolata ~~303~~ 183

" spinulosa-ramosa ~~305~~ 184

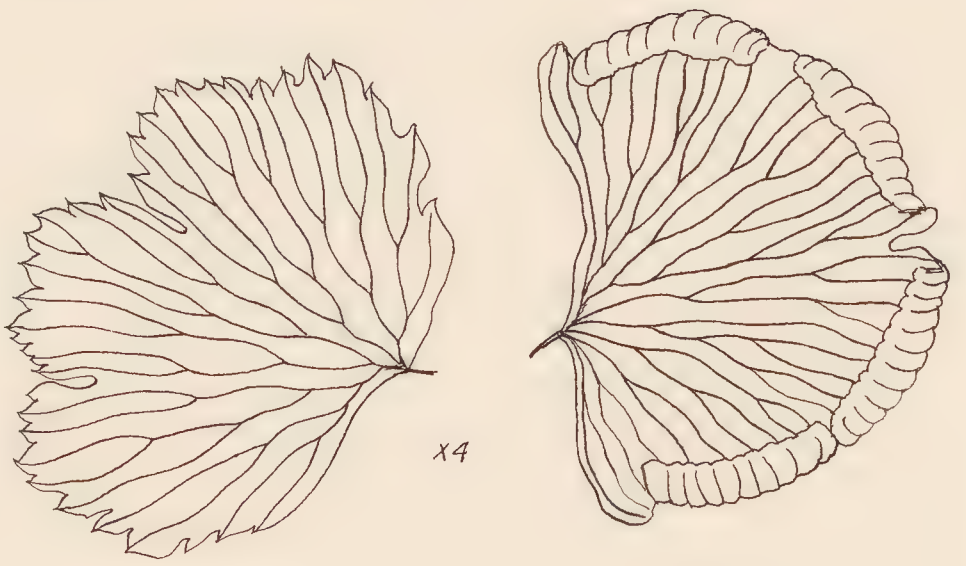
" virginica ~~307~~ 185

Adiantum capillus-veneris.

In California, 1902



Adiantum emarginatum



Adiantum pedatum L.

In Illinois — rich earth on the sides of deep shady ravines (Ravinia 1889); sandy-clay bottoms near Morris (1890); often overflowed by the Mazon Creek, which flows thru and over prolific fossil beds, and may be caught in the act, at times of freshets, of making fossils of such plants as grow in the low places, by burying them deep in the sediment and clay which it has brought from a distance. In moist, wooded hollows between sandridges along Lake Michigan shore line from Evanston to Colehour, 1890; among mossy stones of wooded moraines near Willow Springs, 1890; in Michigan, on wooded sand-dunes at Macatawa 1910; Missouri, in moist, shady, sandy soil, Warrensburg, 1906; high, rich woods, Lamar, 1893; Common all thru Ontario, Canada; along the Niagara River in rich deep woods, and in stony ground; rare on the rocks below the Falls, 1890.

Adiantum pedatum imbricatum. n.var. Prince

A curious variation in the deep shady hollows at Ravinia, Illinois, 1890.

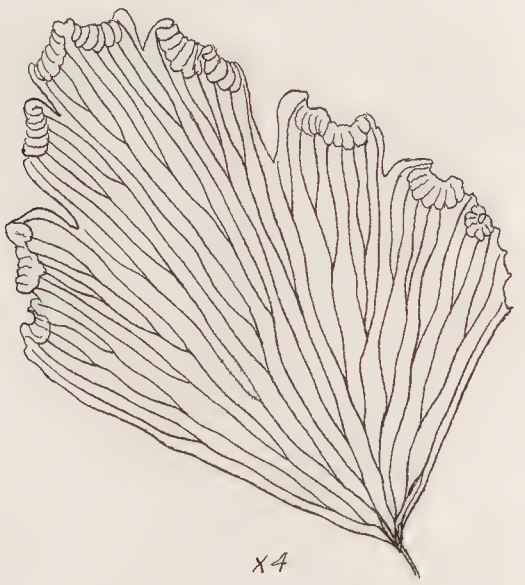
The pinnules were strongly recurved forwards, becoming lunate or scythe-shaped, and set at an oblique angle so as to overlap the one in front. There were but a few plants.



Adiantum pangiferinum

Very common in and around Tacoma, Washington, on vacant lots under sidewalks, on the edge of clearings, and forests. 1902.

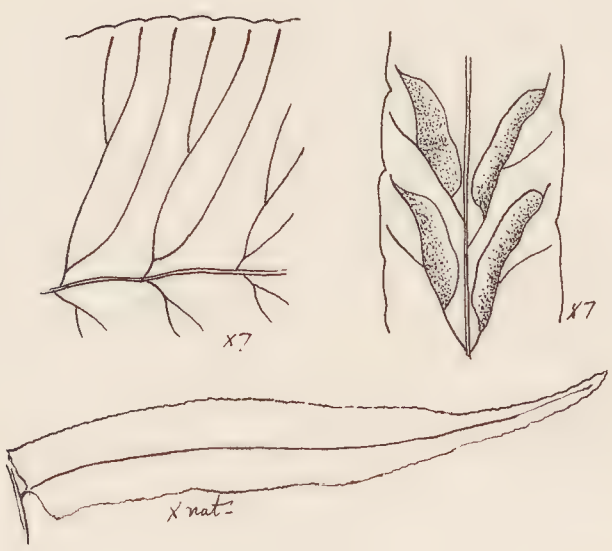
Adiantum tenerum.



x4

Asplenium angustifolium Michx.

Among rocks in the "Glen," Niagara River, Canada, 1890; in sandy, marshy ground, margins of Black Lake, Michigan, 1910.



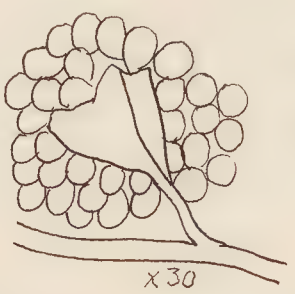
Asplenium trichomanes L.

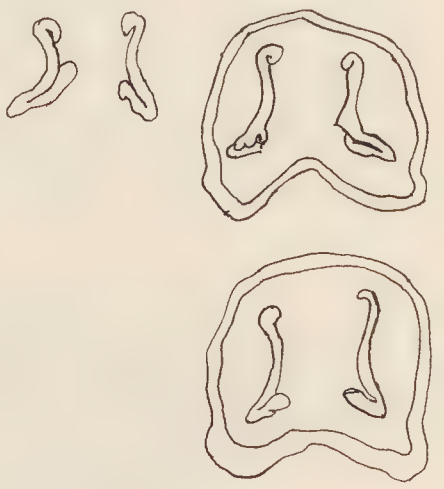
On mossy ledges and boulders, in crevices of rocks, Bailey Creek, Missouri, 1894; Niagara Whirlpool, and in the "Glen," Ontario, Canada, 1890.

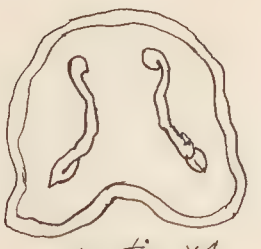
Athyrium cyclosorum Rupr.

Grows rankly everywhere in the vicinity of Tacoma, Lake Washington, Puget Sound, 1902.









Athyrium felix-foemina (L.)

In sandy soil, margins of Black Lake, Michigan, 1910 forming dense, luxuriant growths; 4–5 feet high; in moist, shady woods near Lake Michigan – Ravinia, Ill., to Colehour, Ind., 1891. Illinois – rich woods, Wilmington, Morris, Willow Springs, 1891; common in vicinity of Niagara River, Canada, 1890; Yellowstone Park, 1902





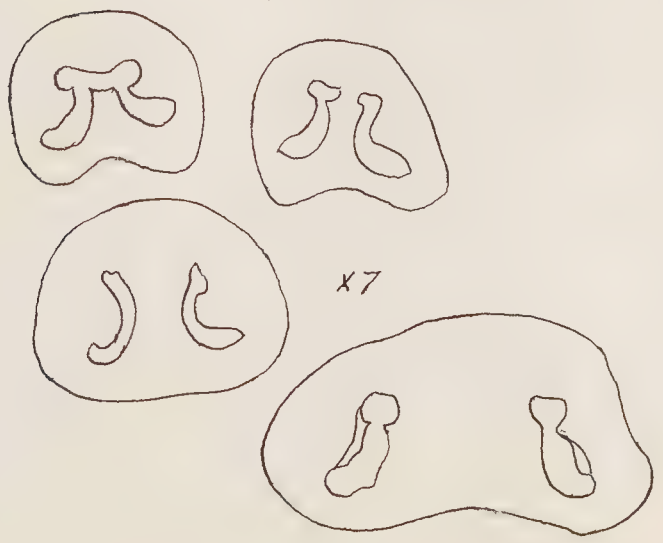
Athyrium felix-foemina latifolium

Rare, in rich woods; Stamford, Ontario, 1890







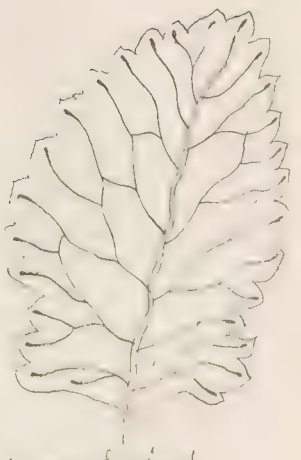


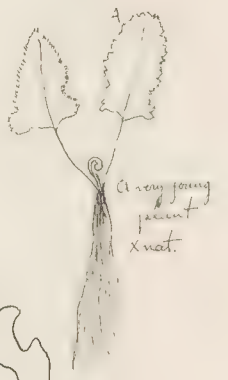
Athyrium thelypteroides (Michx.) Desvx.

Canada – In the "Glen" and Dufferin Islands, Niagara River 1890, hairy, becoming smooth on drying; common in wet or marshy places, Ravinia, Colchour, Willow Springs, Wilmington, Illinois 1892



Blechnum serrulatum


A - very much enlarged

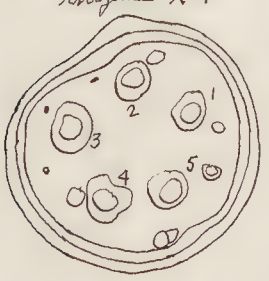

A very young plant x nat.

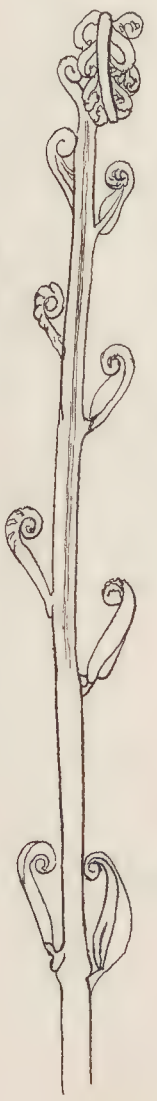
Very common on the sides of the drainage ditches and firmer spots in ~~swamps~~ and marshes in Florida (St. Cloud) 1929-30.

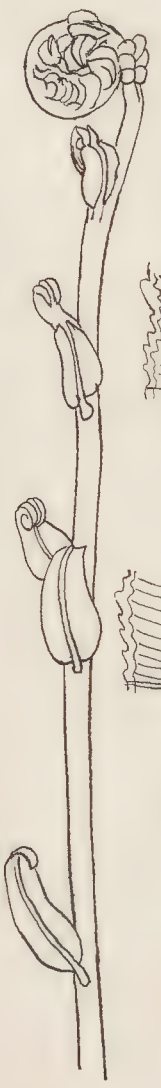
The main rachis is crooked, brittle, almost black, covered with closely appressed, blackish scales, and sends up vertical branches at intervals, bearing a closely crowded crown of fronds. This vertical branch often produces horizontal branches which curve downward. Roots are scattered, round, densely covered with short root hairs. On level ground the rhizome may be 10 or 12 inches beneath the surface. The pinnae have the habit of standing horizontally

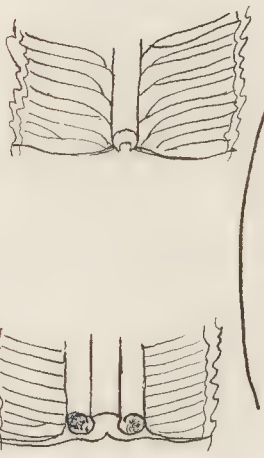

rhizome X 4

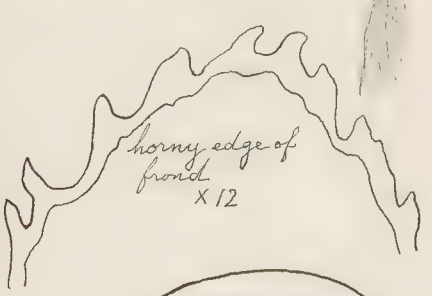

X 4
Stipe

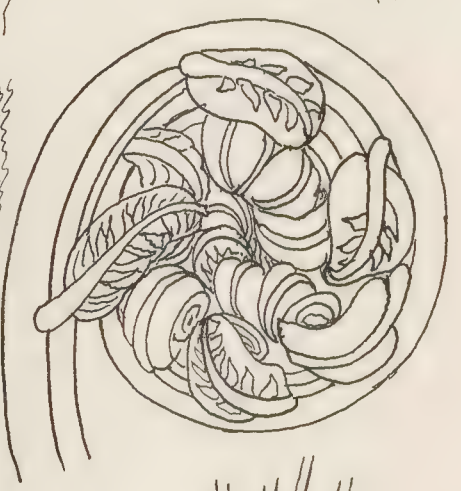




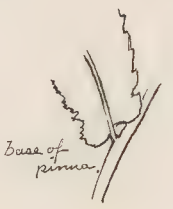


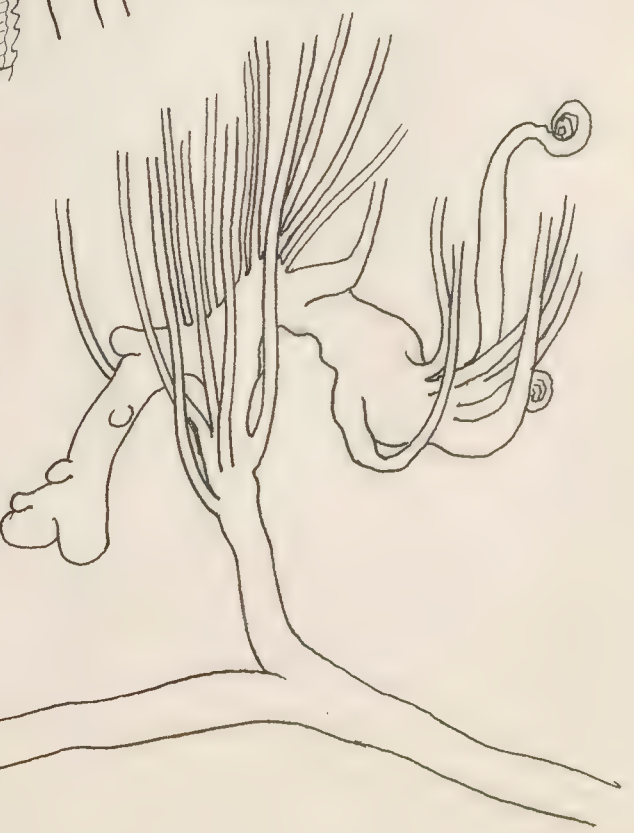



horny edge of frond
X 12




scales on midrib


Base of pinna



Botrychium ternatum obliquum f. intermedium D.C.E.

In rich soil on the islands of the Queen Victoria Niagara Falls Park; very numerous in low ground in McLeod's woods, Canada, 1890; shady sand dunes Macatawa, Mich. 1910.





Botrychium ternatum obliquum f. dissectum Spreng.

Rich soil on Dufferin Islands, Canada, 1890 Very finely cut fronds of intermedium, which may or may not be repeated another year.

Botrychium virginianum (L).

Illinois — small, on high ground, Wilmington Woods, 1889; very large in rich soil, deep, wooded ravines, Ravinia, 1890; common at Colchour, in sandy ground; sides of steep ravines, Willow Springs; in rich clay, Morris, 1890; Shady hollows between sand dunes Macatawa, Mich., 1910. Missouri — in rich woods Lamar 1893; sandy soil, Warrensburg 1902

Camptosorus rhizophyllus (L.) Link.

Wisconsin – Devil's Lake; Madison vicinity; 1875. Michigan – Macatawa, Black Lake, 1910; Missouri, sandstone cliffs, Warrensburg, 1905; Lamar, 1893; Marionville, 1896; Crane, 1896; Galena, Turners, Gorge of Niagara River, moist, mossy rocks.

Cheilanthes lanuginosa Nutt.

James River, near Galena, Missouri, 1893–1912, and in several other parts of Stone County; also on Dewey Bald, Taney County;

Cheilanthes vestita Swz.

On moist ledges of red sandstone, Paris Springs 1895





Cheilanthes wrightii Hook.

In clefts of rocky cliffs on banks of Roaring River, Yellowstone Park, 1902.

Cystopteris bulbifera (L.) Bernh.

In the Whirlpool Ravine, Stamford, Ontario, Canada, 1890, these ferns grew 3 to 6 feet high, in the wet, deep shade, forming a dense mass covering the ground. Missouri — in rich woods at Lamar, 1893; Marionville, 1894. These were all rather bright, tender green, a great contrast in appearance to the rather small, dark green fronds of the specimens from Manhattan, Kansas, gardens, tho all of these agreed in all other respects.



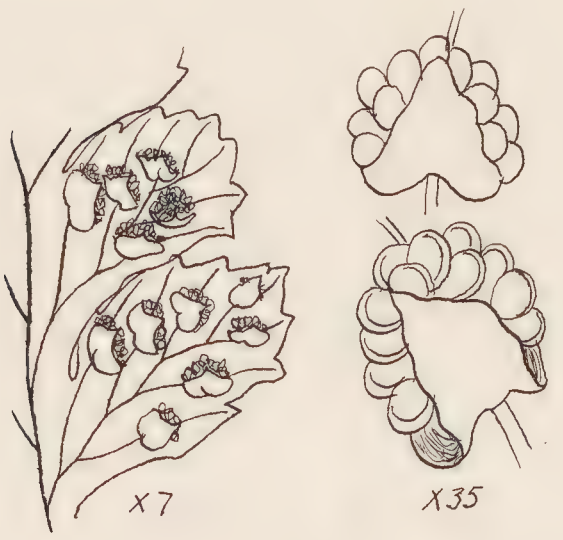
Cystopteris fragilis Bernh.

In my collecting I found many variations of this fern. There were forms with triangular fronds, the lower pinnae being longest, Salt Creek, Illinois, 1913; Turners, Mo, 1912. Burt Lake, Michigan, 1910, a large tender leafage, the stipes longer than the blade. In most of my specimens the lower pinnae are more or less reduced, the fronds narrow- Salt Creek, Illinois, 1913, in high dry woods, some plants having the teeth of the pinnules reflexed over the sori, which are near the margin, Decatur, 1913; very common on the sand dunes near the lake shore north of Chicago, 1891 and in the Des Plaines and Illinois valleys 1891; in Missouri, at Turners 1912, Warrensburg 1906, Lamar 1893, Marionville, 1896, Galena, and many other places.



Cystopteris fragilis deltoidea n.v. Prince

Salt Creek, Ill., 1913; Missouri — galena 1893, Turner's 1912;



Cystopteris fragilis laciniata Davi.

On the ground in high, rich woods, the indusia very typical, Lamar, Mo., 1893

Equisetum arvense

In the marshes near Manhattan, 1925, the gametophytes very numerous.



Equisetum hiemale

In low, damp places, Manhattan 1925

Lomaria spicant Desv x.

In a thickly wooded ravine, Lake Washington, 1902; heavy lumbering operations had completely ruined hundreds of plants

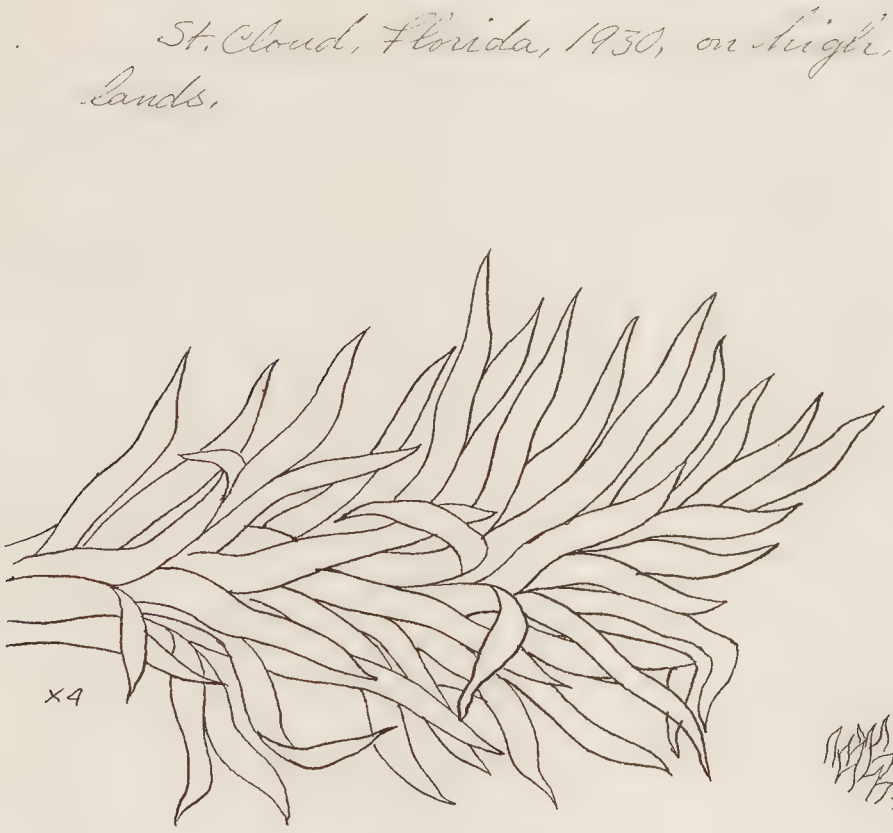
Gymnogramme triangularis

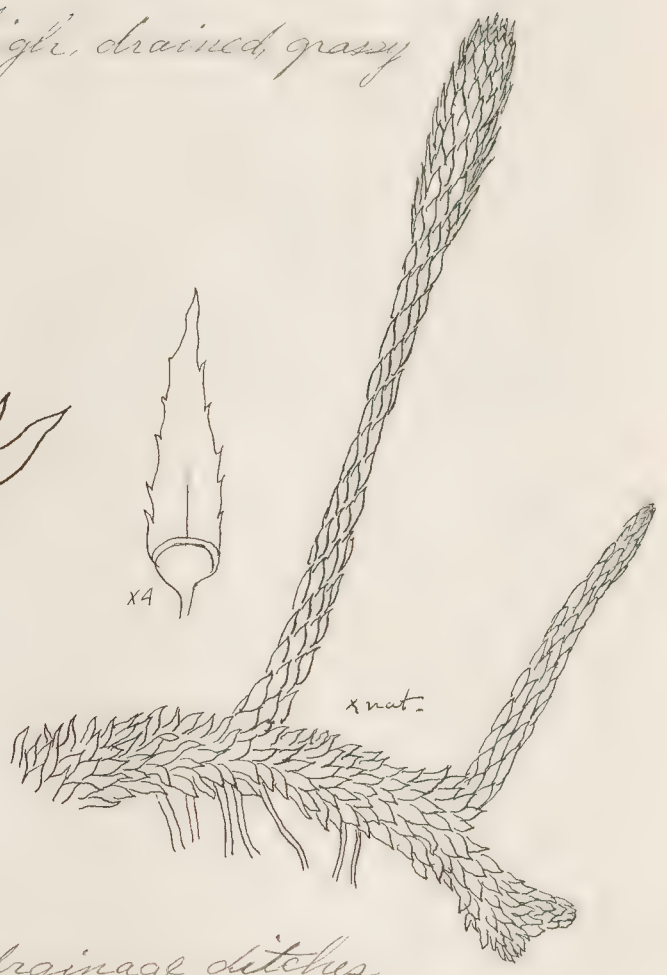
On the ground in thick woods several miles up the canon back of Santa Cruz, California, 1902; below a spring flowing thru micaceous sand.



Lycopodium alopecurioides Foxtail Clubmoss

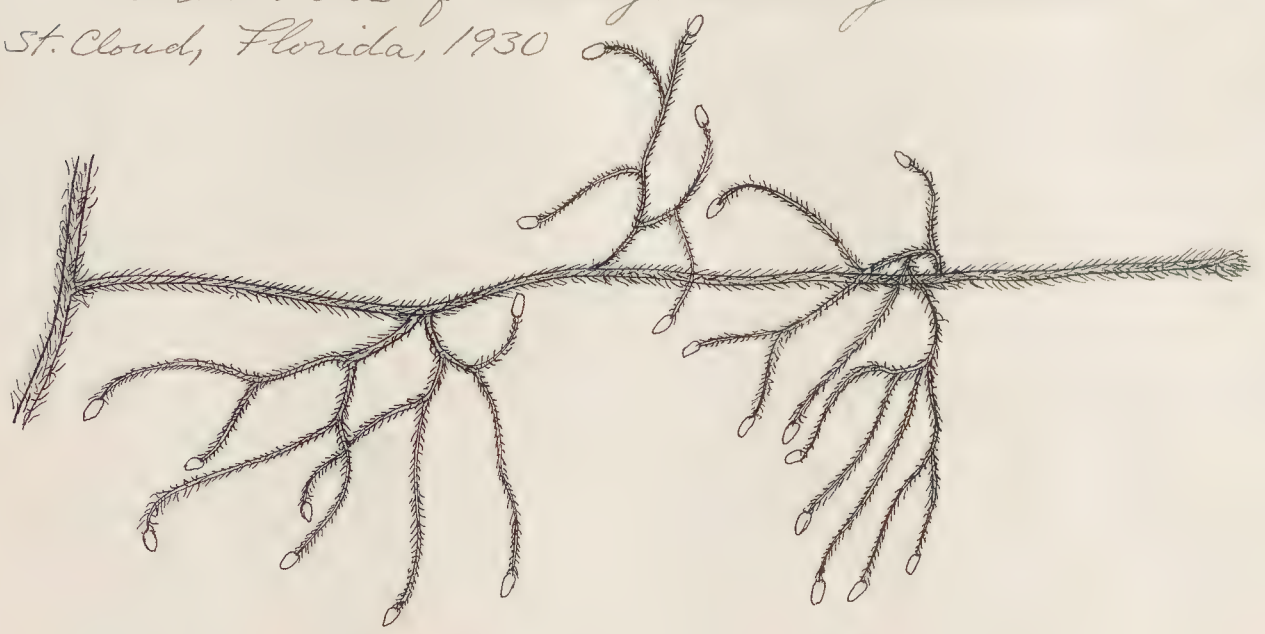
St. Cloud, Florida, 1930, on high, drained, grassy lands.

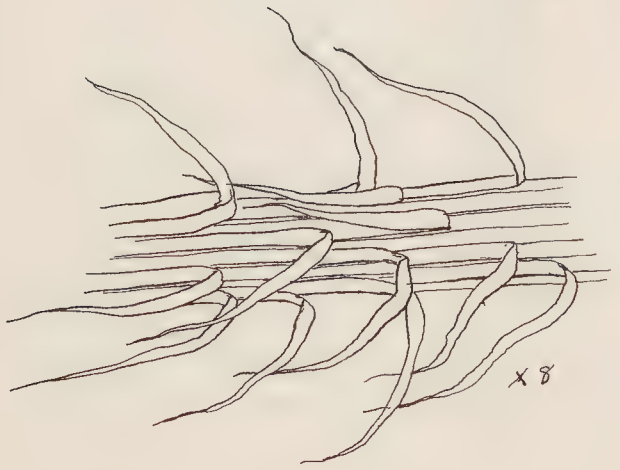




Lycopodium cernuum

On the sides of the large drainage ditches St. Cloud, Florida, 1930



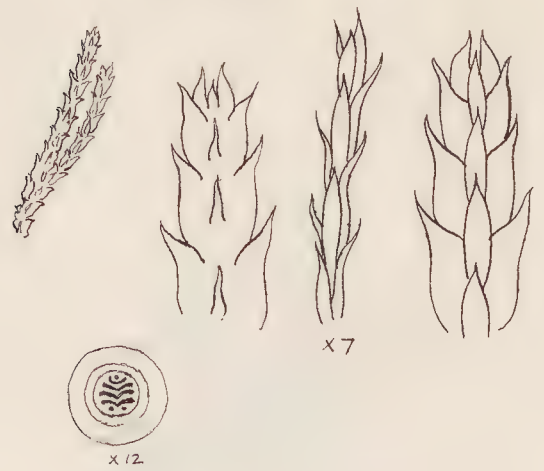






Lycopodium complanatum

At Stamford, Ontario, 1891.



Lycopodium obscurum

At Stamford, Ontario, 1891.

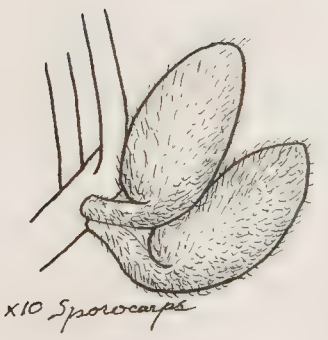


Marsilia uncinata

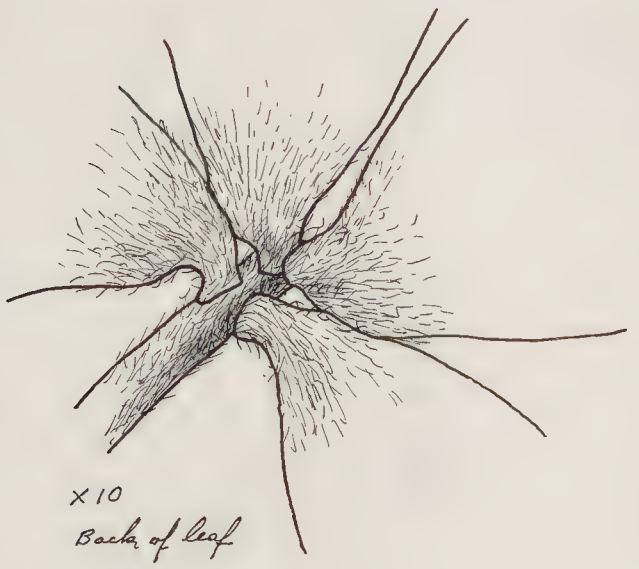


X10

Front of leaf



X10 Sporocarps



X10

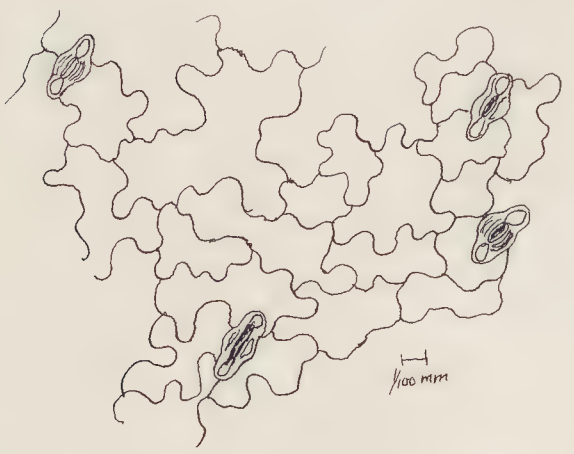
Back of leaf



X10

Marsilia vestita.

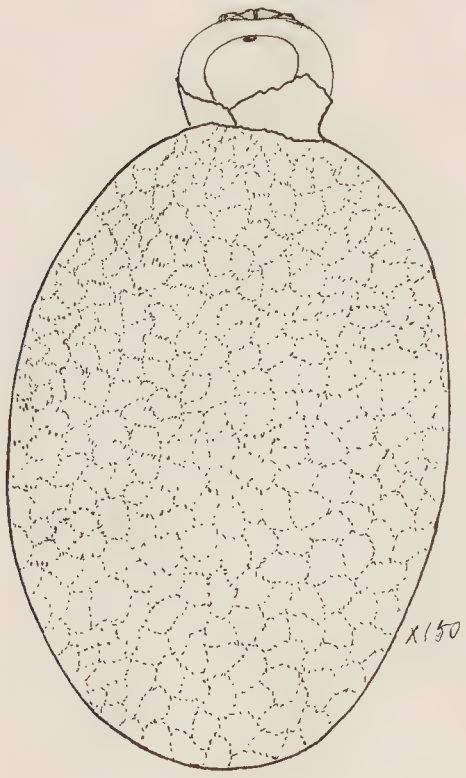
The plant used for this study was raised from a sporocarp brought from Lincoln, Nebraska, January 15, 1918. It began to make visible growth February 15, 1918. Drawings were made April 15, 1918, at which date there were 17 fully developed leaves. May 21, there were 20 leaves besides the spathulate ones, which were taken off and preserved for the herbarium. Up to June it produced 5 new leaves each week, as many at the older end dying. In July the plant was taken to southern Missouri – it was several weeks before it recovered and began to grow as before. From August 1 to the 28th it produced an average of 20 leaves per week, having that many at the latter date, when it was pressed and put into the herbarium.



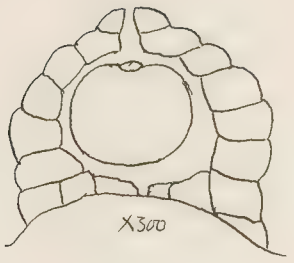
Marsilia vestita



Marsilia vestita-

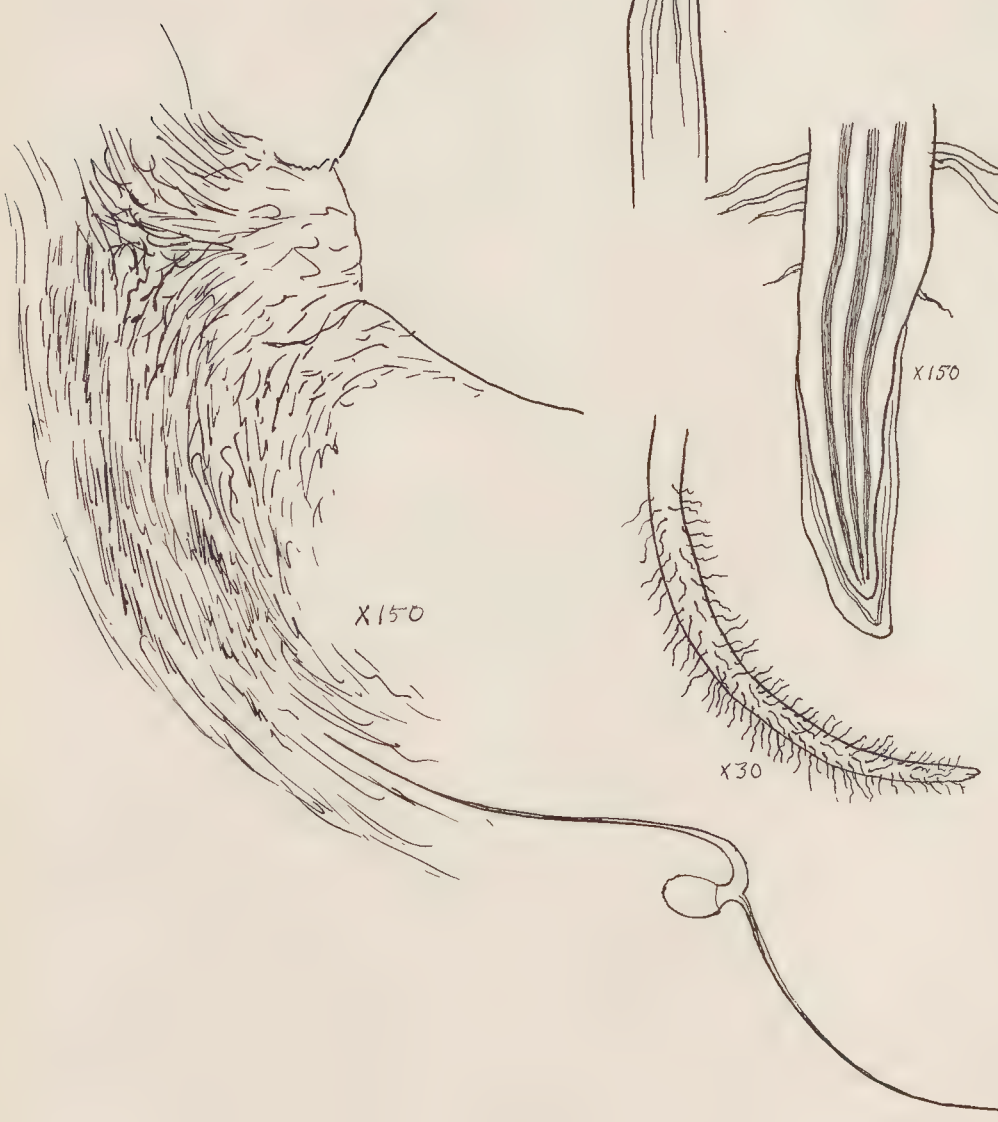






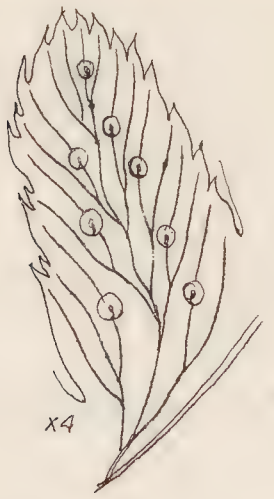








Nephrodium cristatum



Nephrodium cristatum X marginale Dav.

The Dufferin Islands just above Niagara Falls on the Canadian side, were formed by floating logs, trees, pieces of land torn away by storms, etc, grounding in the shallows, and held there by the irregularity of the bottom and the roots of the subsequent growth. The soil is composed almost entirely of rotting vegetation. The flora is very rich. In 1890 I collected 18 species of ferns - on one of these tiny islets.



Nephrodium filix-mas

Nephrodium Goldieanum (Hook.)

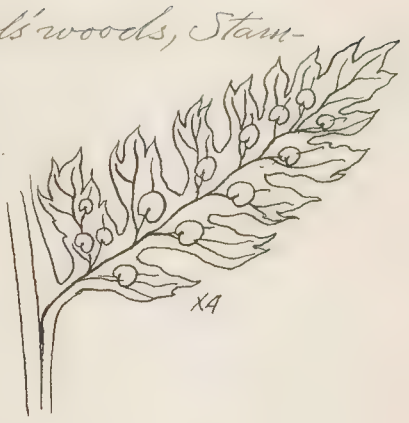
Both of these were found in the same localities in deep, thick woods, the "Glen", Niagara River, Stamford, Ontario, 1890; north end of Lake View, Chicago, in wet, shady woods, 1892.



Nephrodium intermedium (L.) Baker

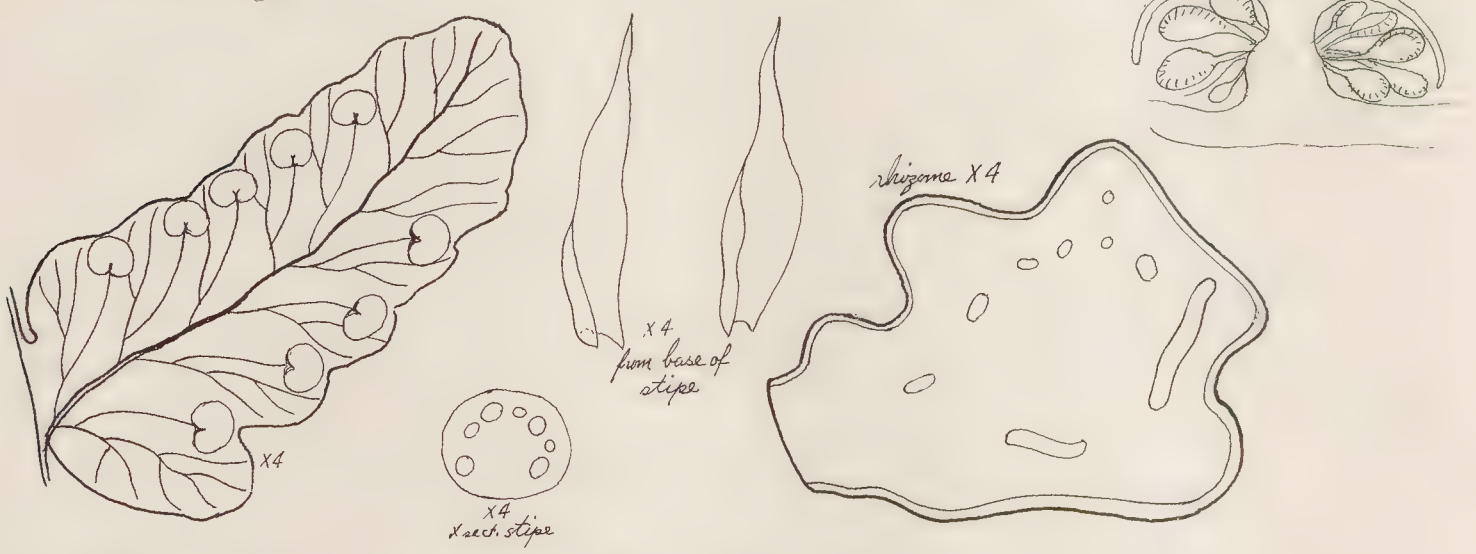
With pink stipes, rare. In McLeod's woods, Stamford, Ontario.





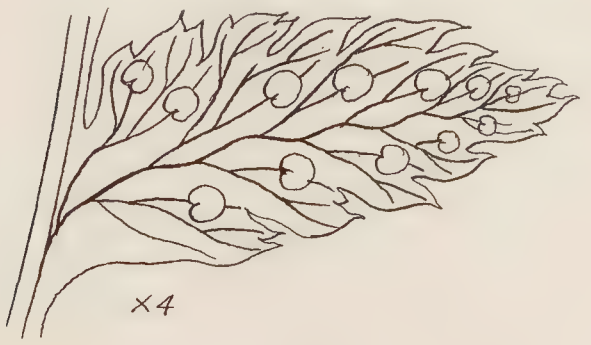
Nephrodium marginale (L.) Michx.

Rich soil of deep woods, vicinity of Niagara Falls, Ontario, 1890, among rocks in the "Glen". On the ground in ravines between heavily wooded sand dunes, and on the sides of the dunes, Macatawa, Michigan, 1910; sometimes on decaying logs, extremely variable



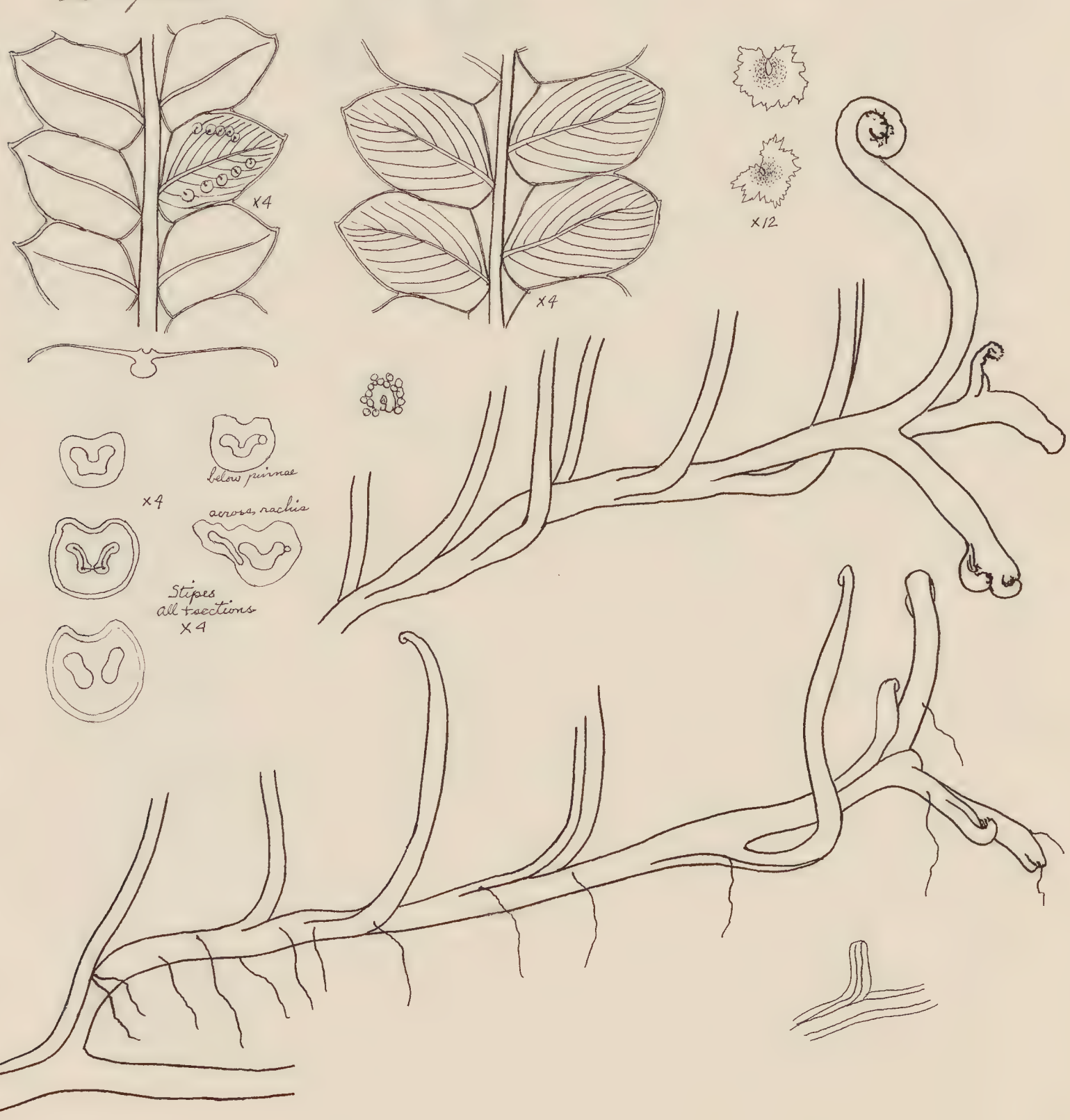
Nephrodium marginale X spinulosum Slosson

On sand dunes and the hollows between, in woods, with marginale, There was every degree of variation between the two, Macatawa, Michigan, 1910.



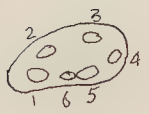
Nephrodium molle Desvx.

at St. Cloud, Florida, growing on the sides of deep drainage ditches, on areas often flooded, and in the marshes; 1930. The back of the fronds are towards the growing end. Sporangia already formed, in June, when the frond begins to unroll. There is a narrow edge of translucent on the edge of the segments



Nephrodium molle



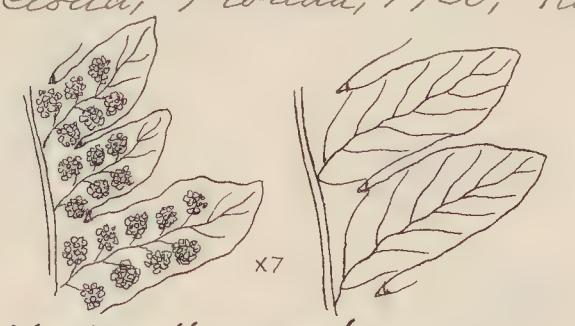


×4



Nephrodium noveboracense (L.) Desvx.

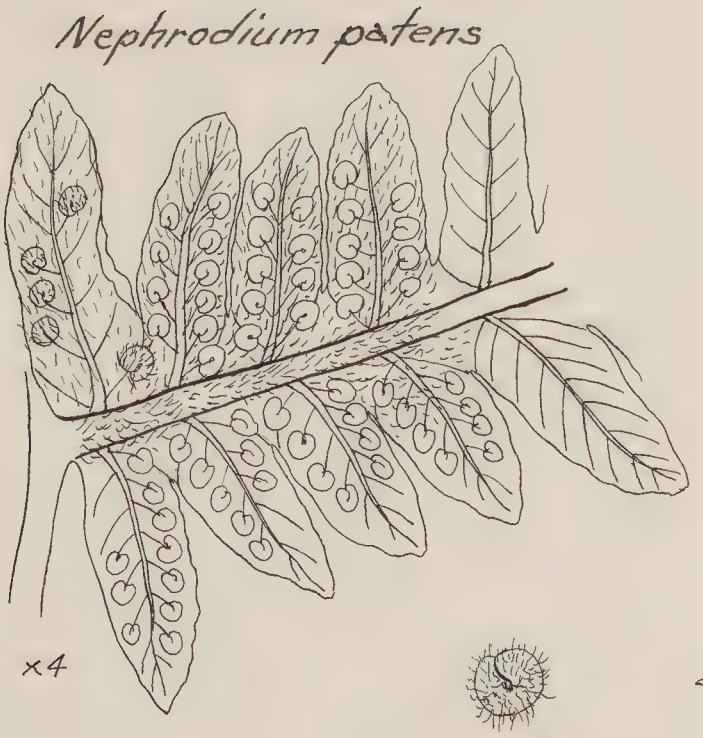
In wet shady hollows between sand dunes along the shores of Lake Michigan, north and south of Chicago, Illinois, 1892; sandy marshy shores of Black Lake, Michigan, 1910; McLeods' woods, Ontario, Canada, 1890; banks of drainage ditches, and swamps and marshes, St. Cloud, Florida, 1930, Note the translucent tissue at the base of each sinus



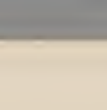
Nephrodium patens

St. Cloud, Florida; in swamps, and on the sides of the drainage ditches, The anastomosis of the vascular tissues is very intricate, and is difficult to follow because the short internodes. The white vessels of one bundle anastomose with each bunde and also with those of the other bundles, The black vessels also anastomose with others in the same bundle, and with the blacks in the other bundles, enveloping the white bundles in a mesh. There are many small, short, spindle-like black cells scattered thru the parenchyma. Basal segments of the pinnae are much the longest, especially the superior ones. Under side hairy with stiff whitish hairs, especially the veins and indusia.

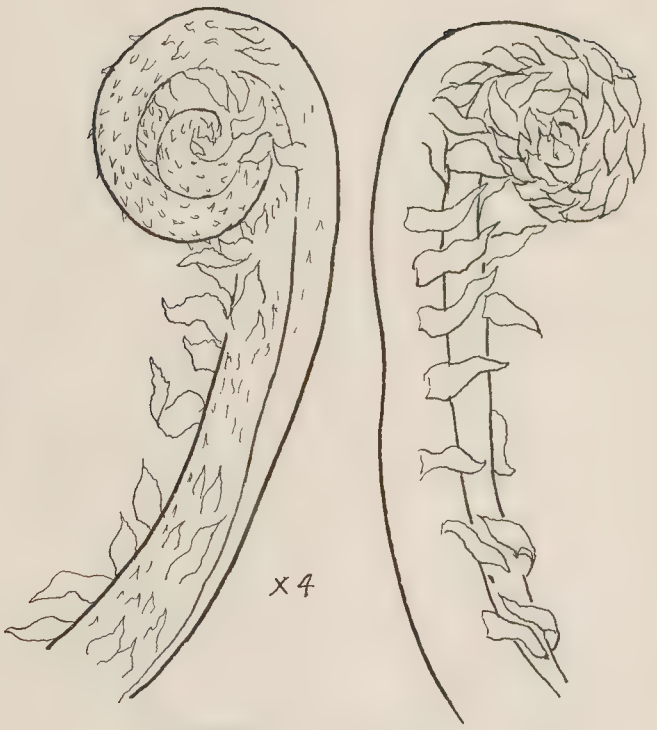
Nephrodium patens



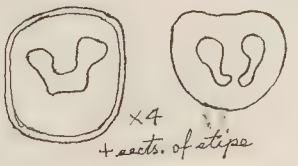
×4



×8

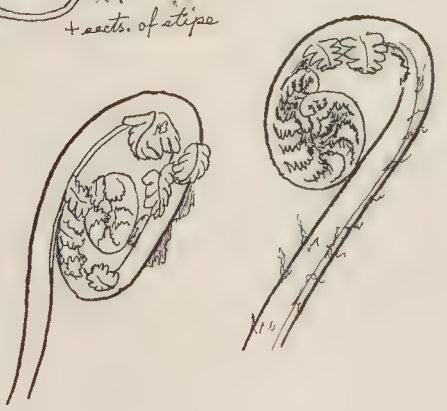


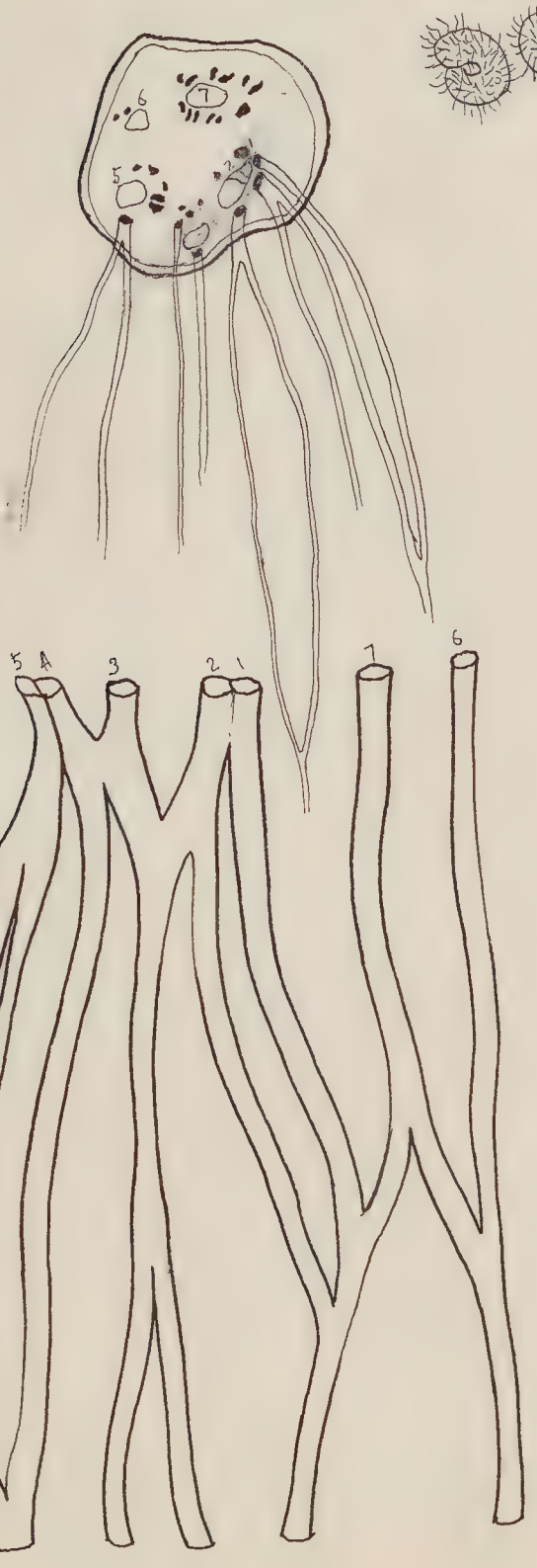
×4



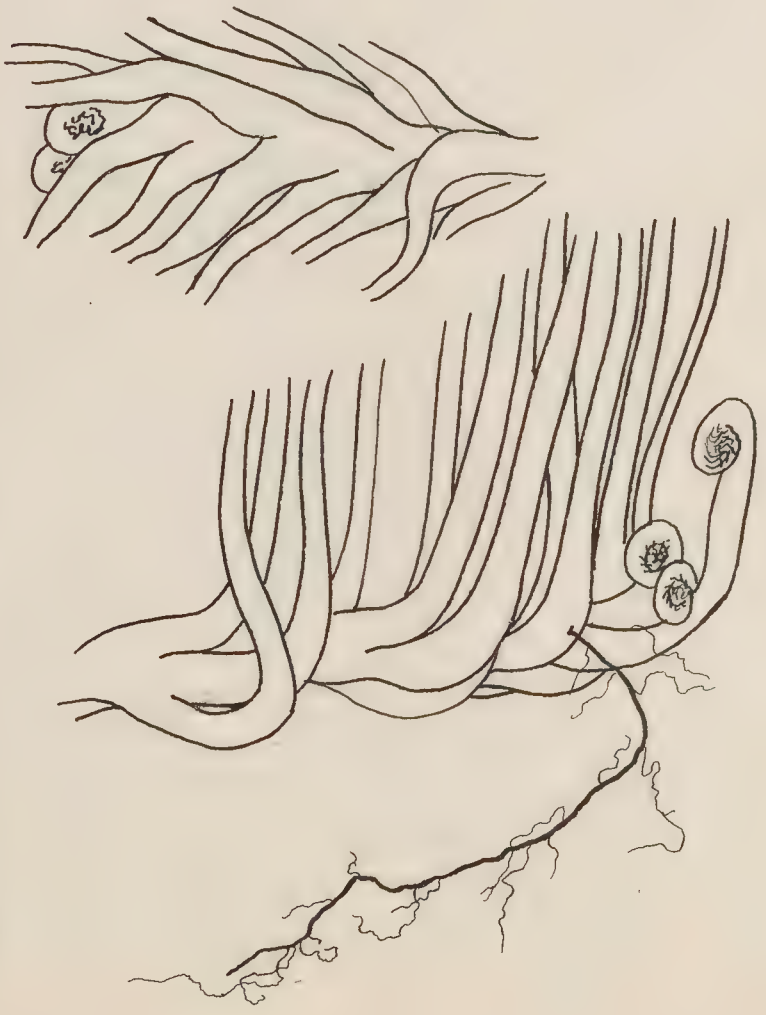
×4
+ sects. of stipe





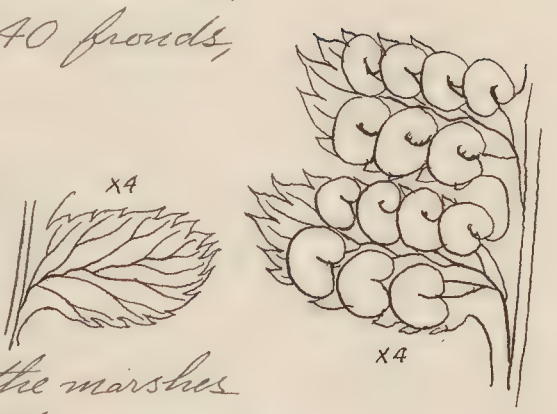


×4



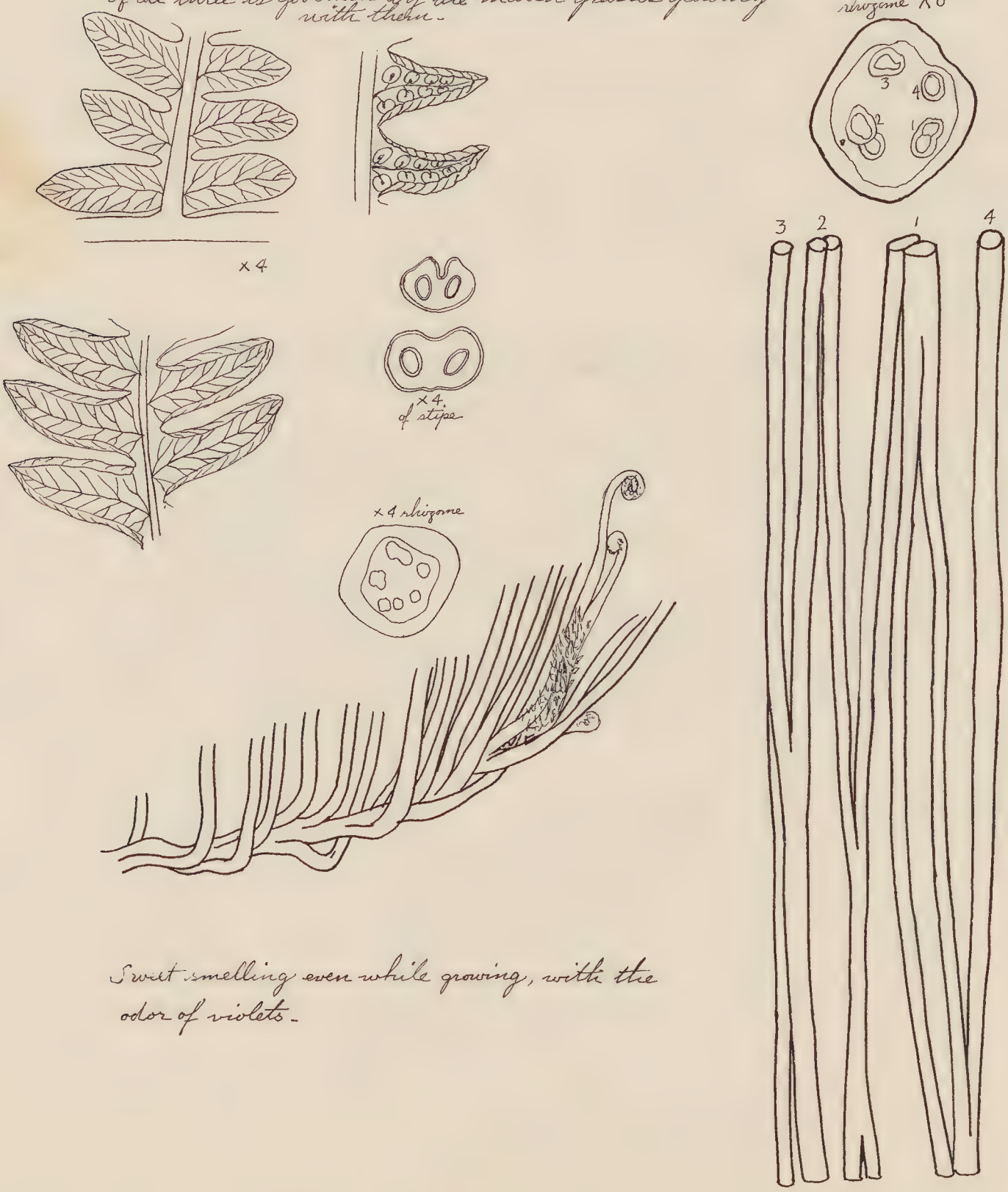
Nephrodium rigidum argutum (Kaulf.) Dav.

In the deep humus of a dense forest near Tacoma, Washington, 1902. There were about 40 fronds, 3 to 6 feet long, on this one plant.



Nephrodium simulatum
(Nephrodium noveboracense X thelypteris)

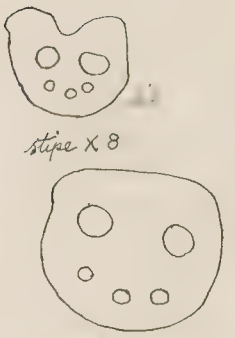
St. Cloud, Florida, 1930. Growing in the marshes and on the sides of the drainage ditches, in dense tangled masses with thelypteris and noveboracense. The length of all three is governed by the marsh grasses growing with them.

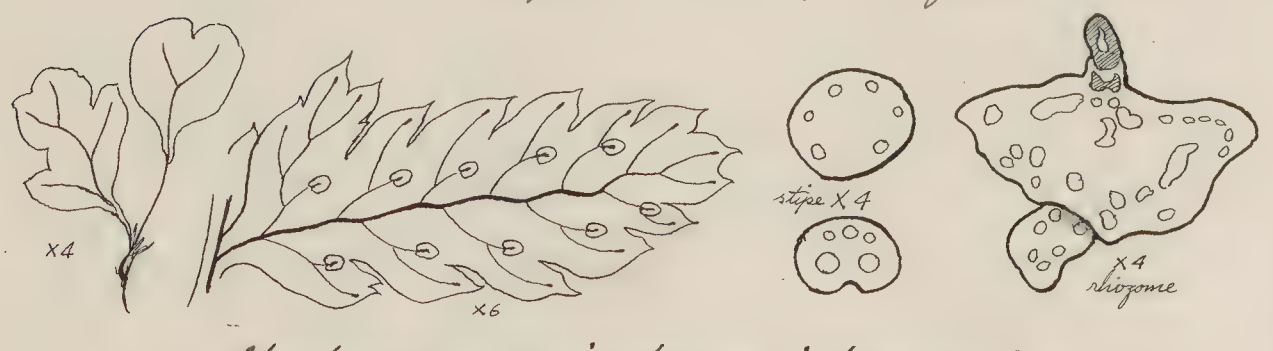


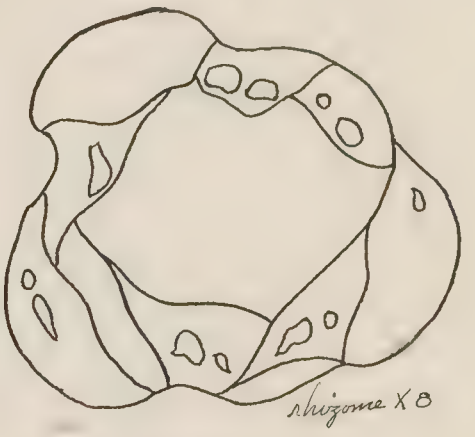
Sweet-smelling even while growing, with the odor of violets.

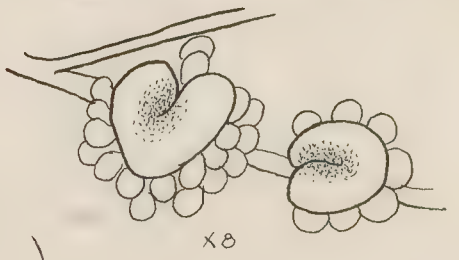
Nephrodium spinulosum (Muell.) Ktze.

Among the sanddunes with marginale and hybrids, in deep shady woods, Macatawa, Michigan, 1910; Dufferin Islands, Niagara River, 1890.





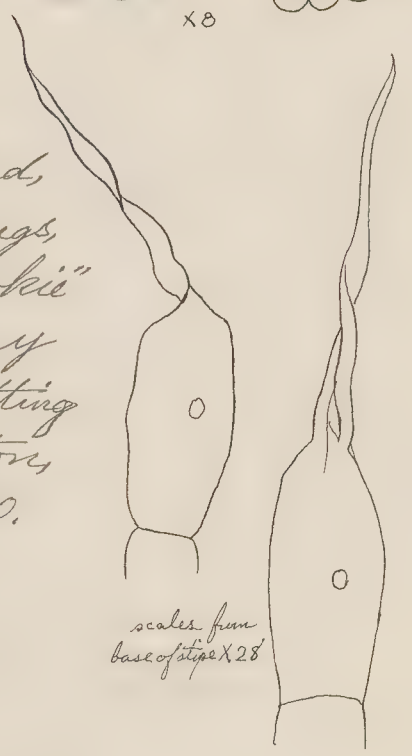




Nephrodium spinulosum intermedium

Nephrodium spinulosum dilatatum (Hoffm.)

On a rotting stump, three feet above the ground, in a wet, dense, dark woods, near Willow Springs, Illinois, 1890; on a decaying stump in the "Skokie" marsh, north fork of Chicago River; woods very dense — the light weak as twilight, 1892; rotting logs in a dense forest, near Tacoma, Washington, 1902; Dufferin Islands, Niagara River, 1890.





all drawings are spinulosum

Nephrodium thelypteris (L) Desvx.

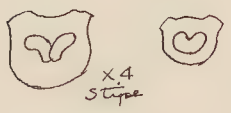
Very common in the vicinity of Niagara Falls, among the rocks in the "Glen," and the "Gorge" below the "Whirlpool," rare and small just below the falls,-sometimes very hairy beneath, 1890; on the margins of Black Lake, Michigan, 1910; common in wet and marshy places in the lake region of Illinois-Indiana-Ravinia, Colehour, "Skokie," Willow Springs, Morris, Wilmington, 1890; marshy places and sides of drainage ditches, St. Cloud, Florida, 1930.

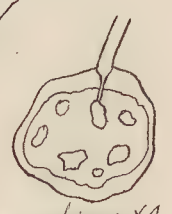
The fertile fronds wilt more quickly than the sterile.

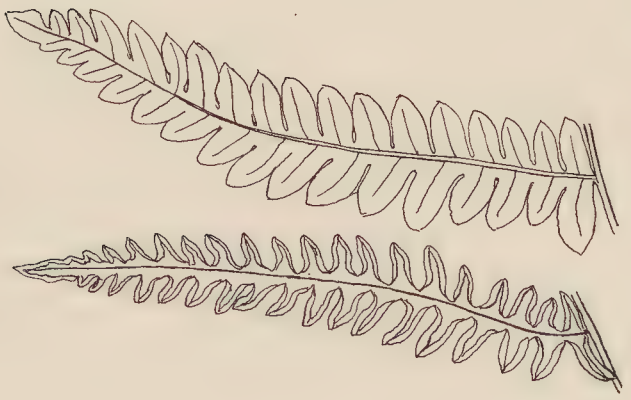


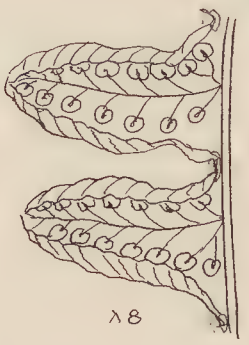
Note a translucent area at base of each sinus

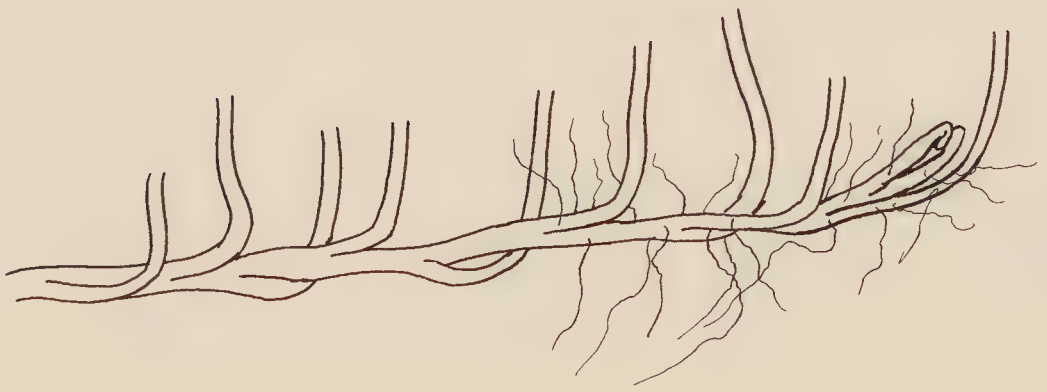








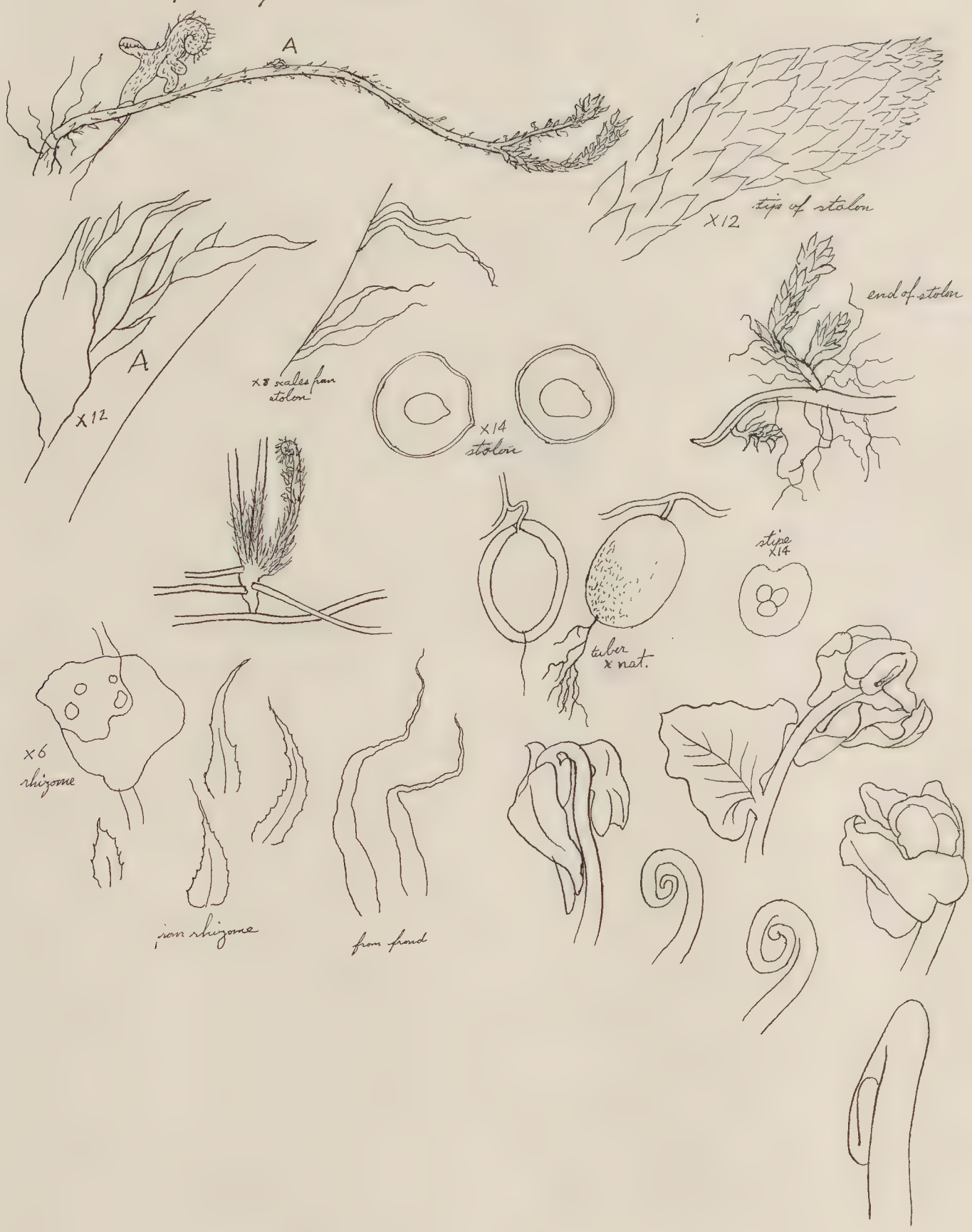








Nephrolepis exaltata



Nephrolepis exaltata

The fronds continue to grow as long as the apical cell is uninjured; rachis narrowly wing-margined, bearing opposite leafy green blades. Unfavorable periods for growth were marked by smaller pinnae. A great many stolons are produced, some burying into the soil, producing roots, and coming to the surface, throwing out a crown of fronds: the aerial ones bear buds which root and produce new plants. St. Cloud, Florida, 1930.

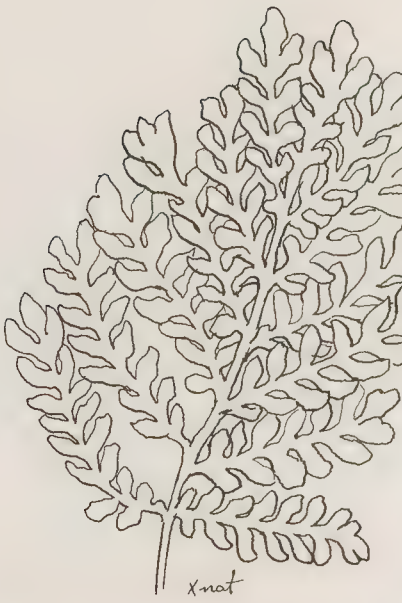
Notholaena Fendleri Kunze

Mountains back of Santa Cruz, California, 1902

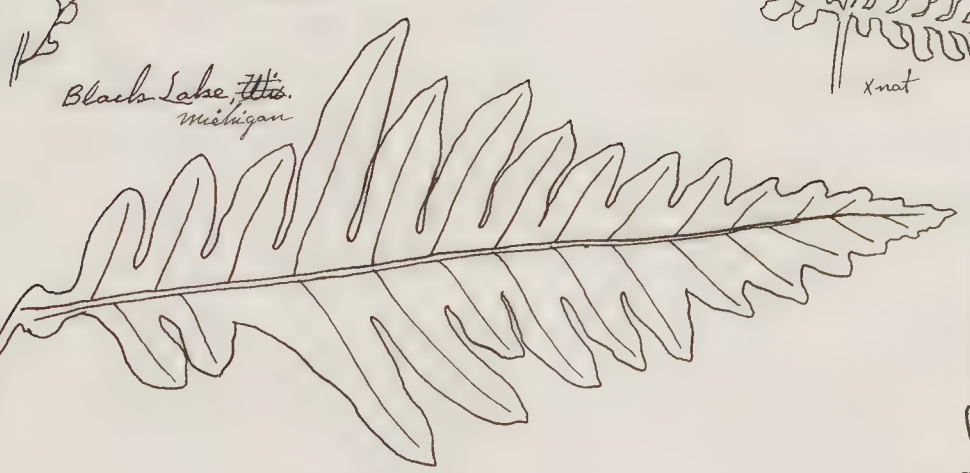
Notholaena Parryi D.C.E.

crevices of exposed rocky cliffs, Roaring River, Yellowstone Park, 1902.

Onoclea sensibilis obtusilobata

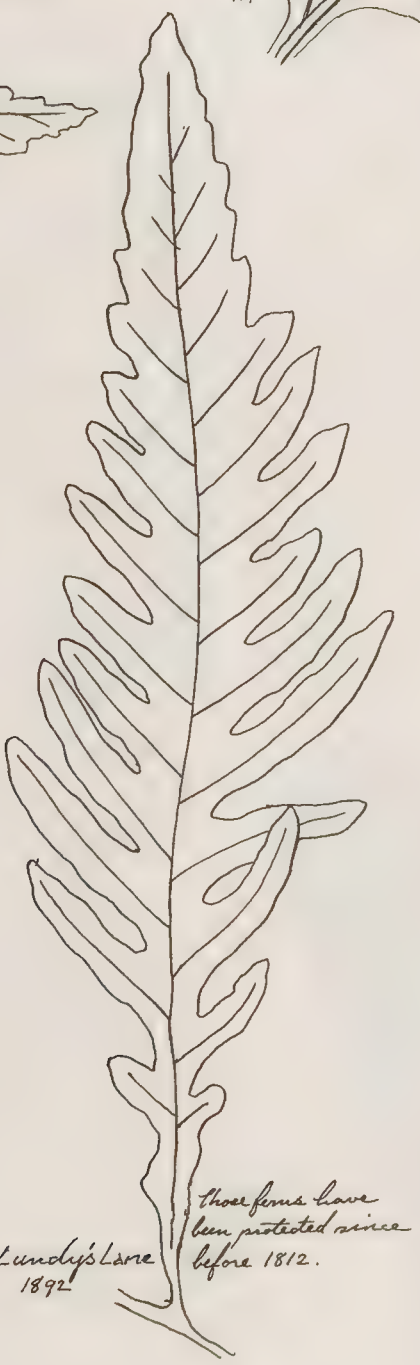












Onoclea sensibilis L.

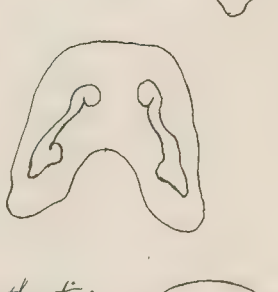
Illinois — in open marshy ground, and in wet woods near the canal, Willow Springs, Morris, Wilmington, 1890; wet sandy soil between sand dunes in Lake View, Rogers Park, Ravinia, to Colehour, 1888–1890; sandy edges of marshes, Black Lake, Mich., 1910; sandy soil at edge of creeks, Warrensburg, Mo. 1905; crevices of red sandstone ledges, kept wet by a little spring, Paris Springs, Mo., 1906. There were many obtusilobata fronds on these latter plants.

At Warrensburg (1905–1909), some rhizomes were transplanted to highly enriched garden soil, not shaded. The plants grew luxuriantly and produced large numbers of the obtusilobata form among the type form of leaves.

A lattice screen was built, dividing the mass. Those north of the screen maintained the variety form, while those south of it reverted to type. Roots were not disturbed in any way.

In vicinity of Niagara Falls, the "Glen," Dufferin Islands, Lundy's Woods — fronds almost bipinnate, 1890.



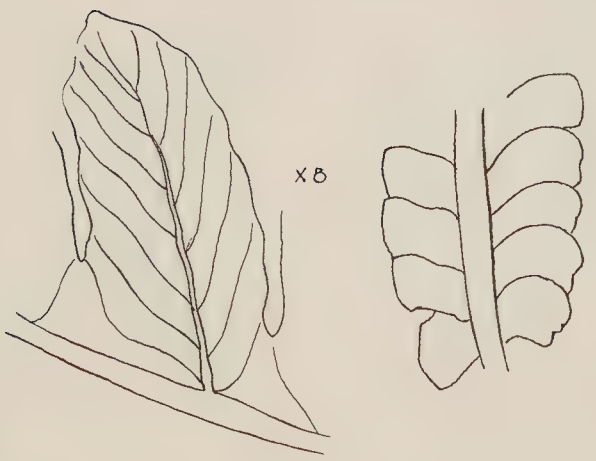


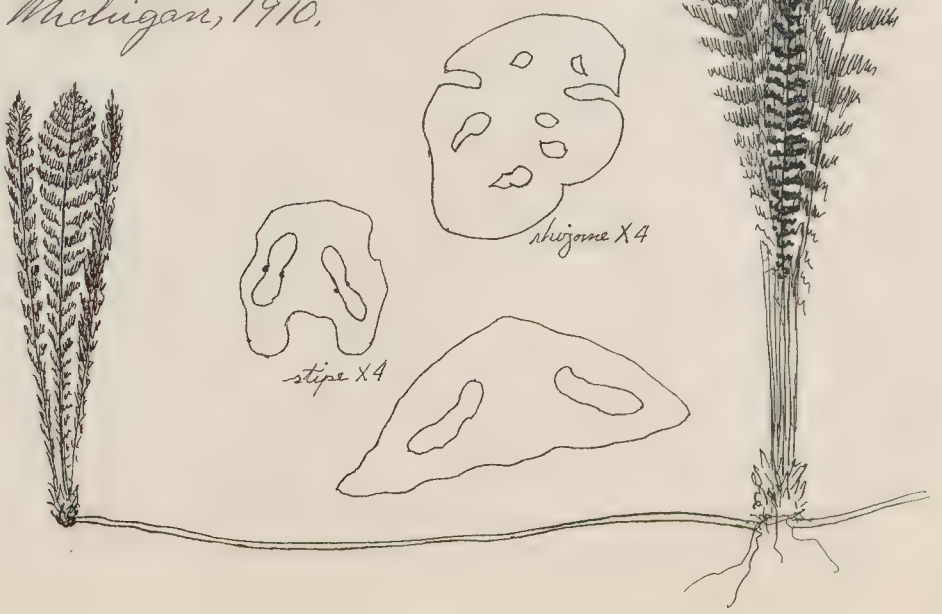


Onoclea struthiopteris

In vicinity of Niagara Falls, Canada, Whirlpool Ravine, Dufferin Islands, the Beech Woods, 1890; in damp shady ravines, Ravinia, (7 feet) and other parts (3 ft) of Ill., 1890; Macatawa, Black Lake, Michigan, 1910.







Osmunda cinnamomea L.

Scattered growths in moist places, Macatawa, Mich., 1910; in same localities in Illinois, 1890, as regalis.

Osmunda claytoniana L.

Scattered plants in moist, shady ravines, from Ravinia to Colehour, 1890; in the Syene Marsh, near Lake Wingra, Madison, Wis., 1876, was a thicket of these 5-7 feet high, ¼ mile wide, ½ mile long; Canada – a dense growth in McLeod's Woods, 4 feet high; Dufferin Islands, Griffith's Woods, 1890; Sterile fronds rare, much shorter than the fertile.

Osmunda regalis L.

Illinois – Deep rich soil, very luxuriant, a bad weed in gardens, north Chicago; some clumps 15-20 feet around – 5 to 7 feet across, larger plants with bare centre; some plants with fertile pinnae altered to cornucopia shape. Smaller in woodlands – Willow Springs, Morris, Wilmington, Ravinia, 1889 – Macatawa, Mich., 1910; St. Cloud, Florida 1930.

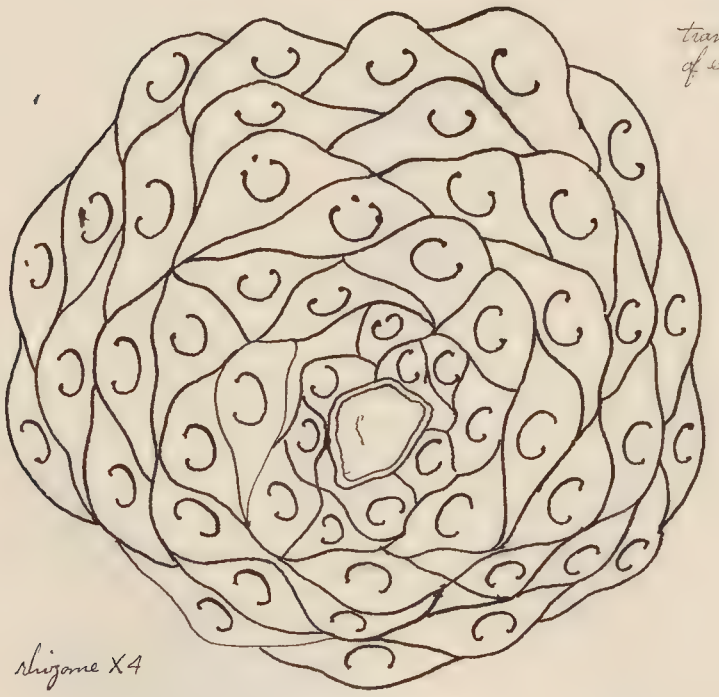
Osmunda cinnamomea



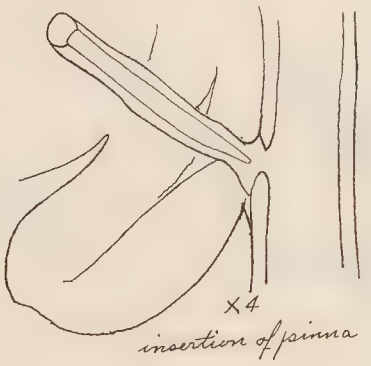
stipe X4

translucent tissue at base of each sinus

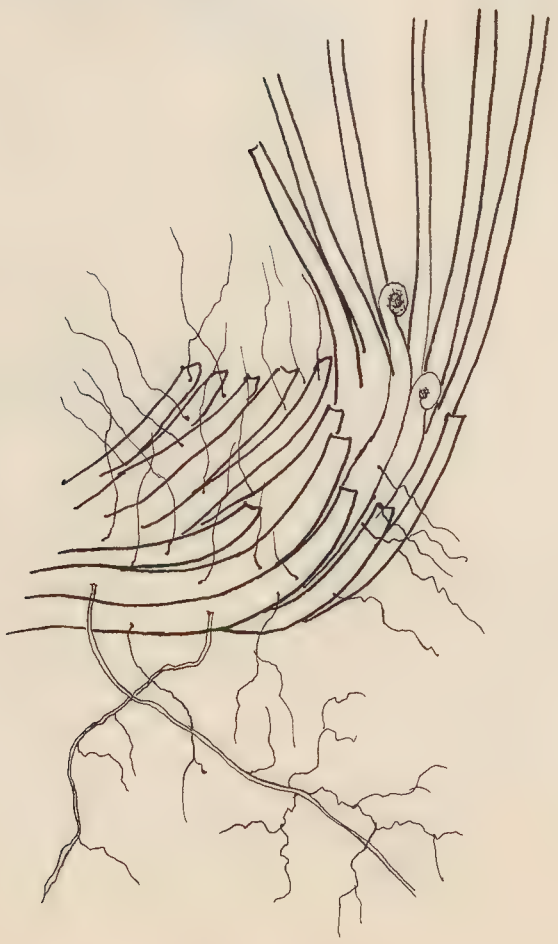




rhizome X4



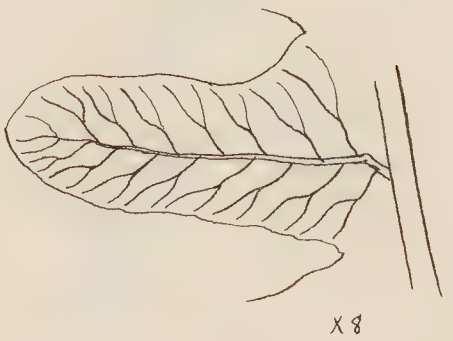
X4
insertion of pinna



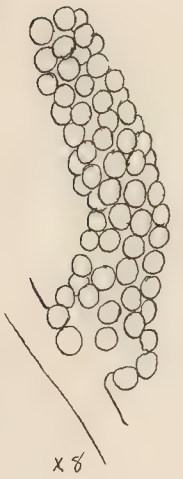


Osmunda ~~regalis~~ claytoniana





x8



x8



x8



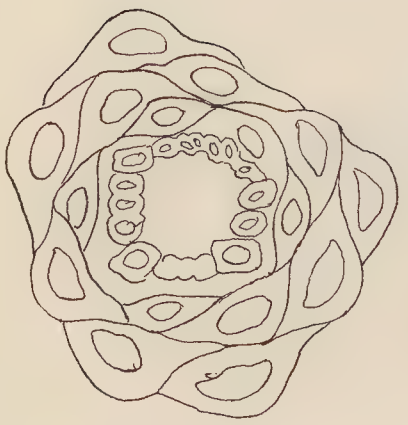
x 1/12



stipe x4

regalis





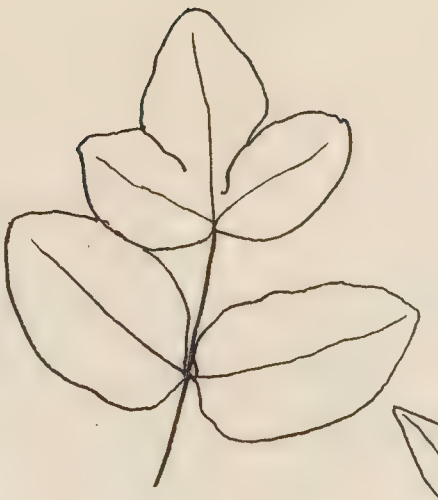
rhizome x4



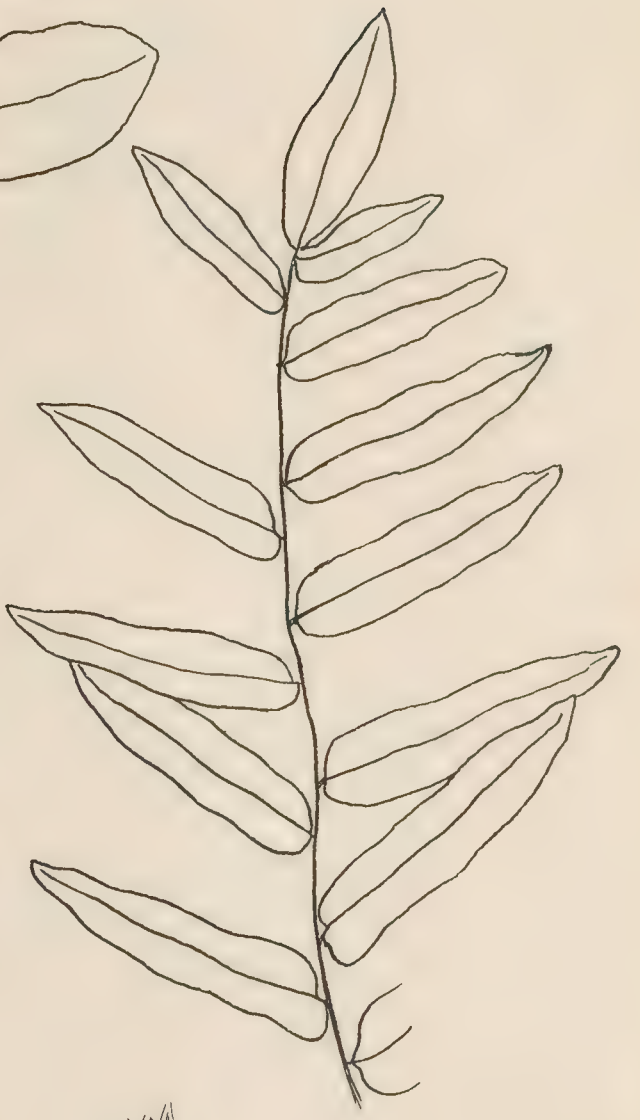
Osmunda regalis





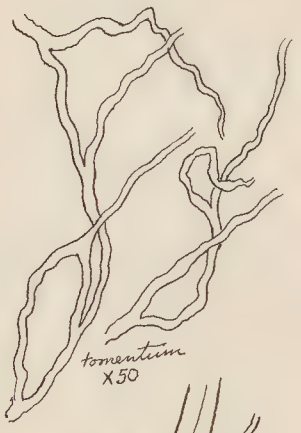


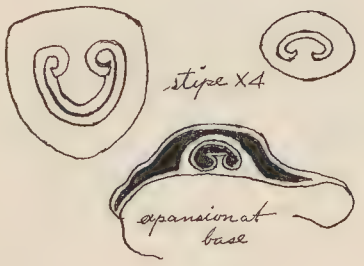


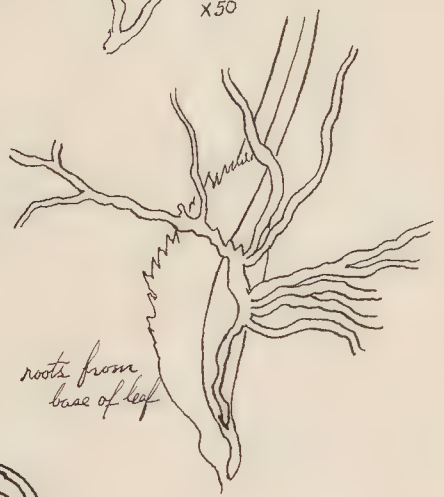


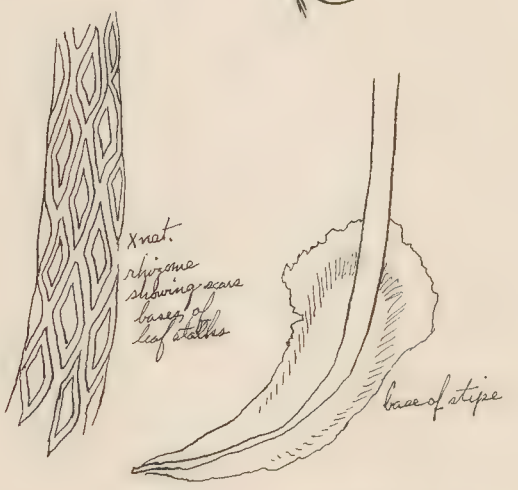


















Section thru base of leaf stalks at A

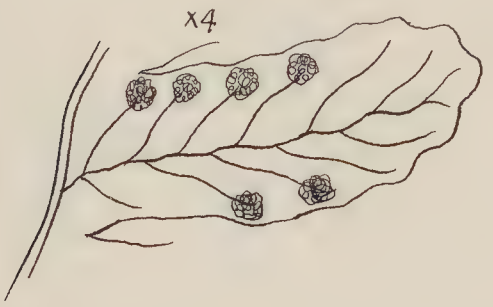
Pellaea atropurpurea Link.

Madison, Wis., bluffs on the four lakes, 1875-6; Devil's Lake, Wis, 1875; Missouri - Turners 1912; Bluffs on the James River and the various creeks and cañons of Stone County - one of the most common ferns - 1893 -

Phegopteris dryopteris (L) Fee

On the inner Dufferin Island, Niagara River, Canada, 1890

x4



Phegopteris hexagonoptera (Michx.) Fee.

Ravinia, Illinois – rich earth in low, moist woods, 1891; Canada 1890 – vicinity of Niagara Falls, Lundy's Woods, McLeod's woods; Missouri, 1894, Moist hollows and shaded ravines, near Galena, in southern Stone County, Marionville, etc. 5

Phegopteris polypodioides

Phegopteris tetragona

St. Cloud, Florida, 1930, – on the sides of drainage ditches, in marshes, etc. Rhizomes very short, roots long (12") flexible, uneven, dark brown, copiously branched densely matted spreading horizontally, stipes becoming dark purple with age, veins in lower pinnules twice-forked – all others simple.

Indusium very delicate, soon crumpled up and hidden by the sporangia

Phegopteris tetragona

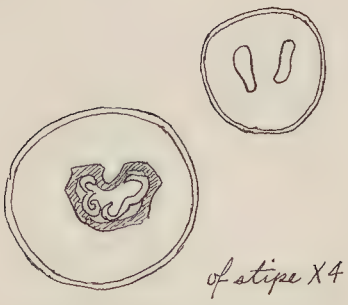


X4



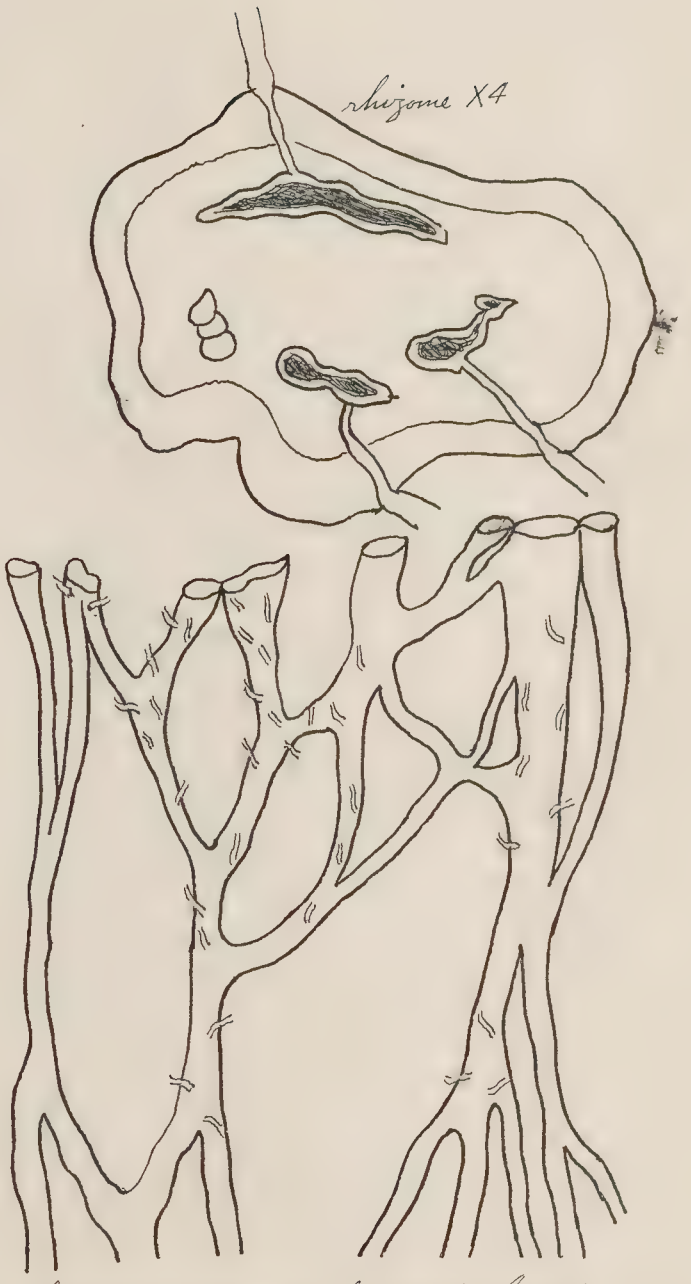


base of stipe



of stipe X4





rhizome X4

showing anastomosis of vascular bundles and origin of roots

Polypodium aureum

St. Cloud, Florida, 1930, on upright trunks of trees in swamps.

Polypodium incanum

St. Cloud, Florida, 1930, on trees in the great swamp.

Polypodium vulgare L.

Canada, 1890 – the "Glen," on mossy rocks, and in crevices; Dufferin Islands, on mossy logs and old stumps; Washington, Tacoma, on rotten logs in dense forests, 1902; Michigan, Macatawa, on rotting wood in the sand of the dunes, sometimes ascending the base of a tree



Polystichum acrostichoides (Michx.) Schott.

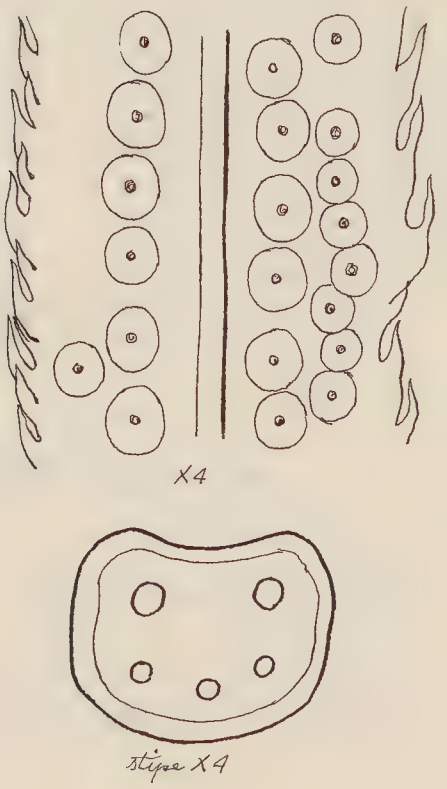
Illinois – Ravinia, on rich ground, sides of thickly wooded slopes; Wilmington, 1890; Missouri – Lamar, 1893, Springfield, 1896, Warrensburg, 1902, very common in southern Stone Co.; Canada, 1890, Lundy's Woods, on the ground; Dufferin Islands; Whirlpool Ravine, Niagara River, in crevices of rock.

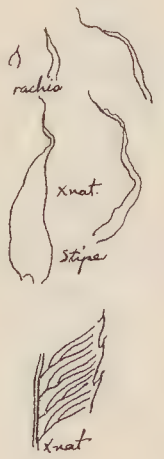
Polystichum acrostichoides incisum

With the type everywhere, but rather rare. Canada, 1890; Illinois, 1890; Missouri – Warrensburg, 1905; Turner's, 1912; Stone County 1893 –

Polystichum munitum inciso-serratum (D.C.E.) Undw.

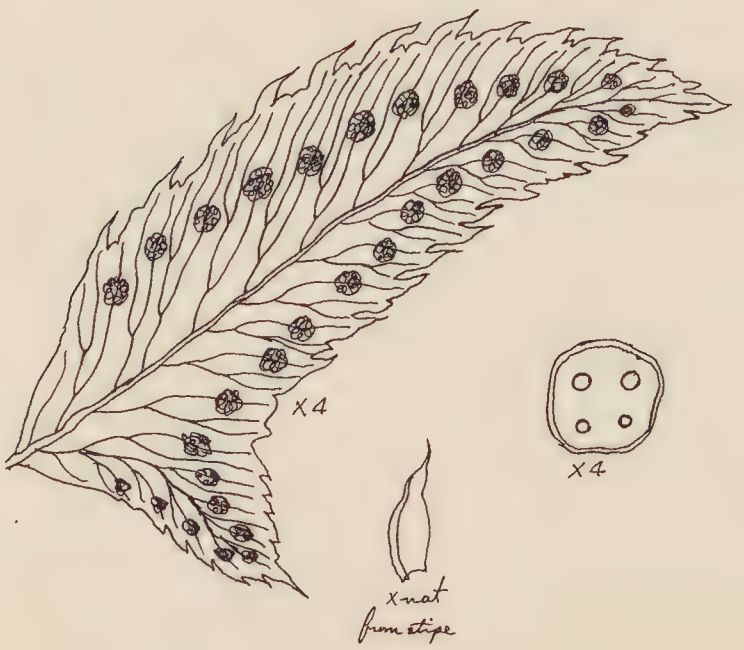
In deep woods, Lake Washington, near Seattle, 1902. Some of these beautiful plants bore from 15 to 40 fronds, many of which, in a curve touched the ground six or seven feet away. There were double rows of sori on some of these leaves.







Polystichum lonchitis



Pteris aquilina L.

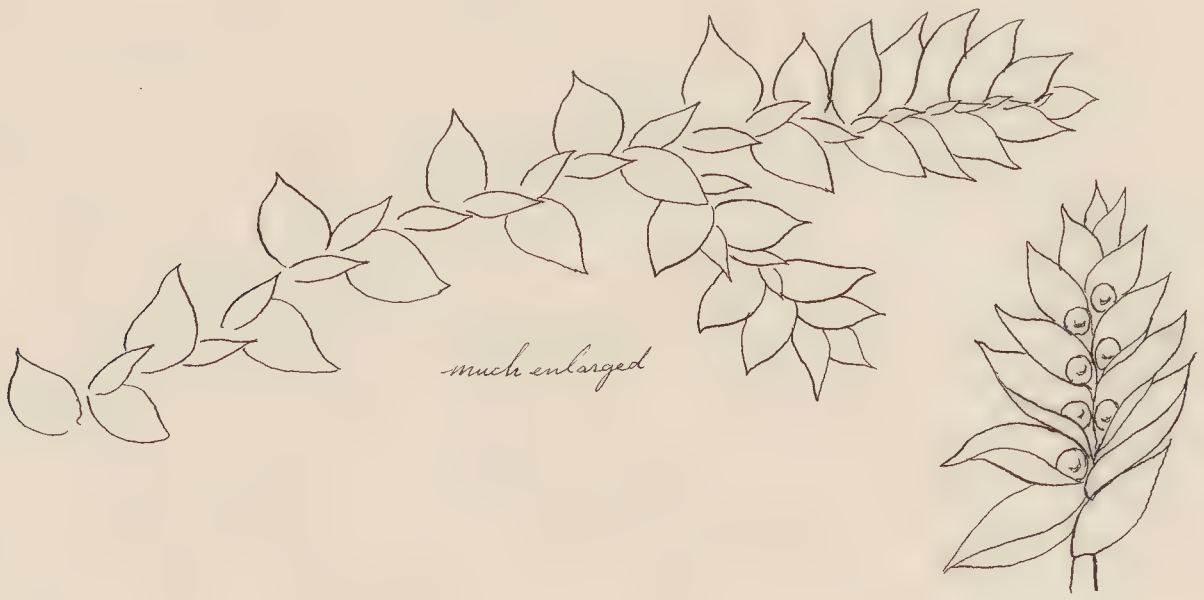
Canada - common everywhere, vicinity of the Niagara River, 1890; Washington - Tacoma to Seattle, often very large, 12 to 15 feet long, reclining on shrubs and among the low branches of trees at the edge of forests, 1902; Michigan - Macatawa, 1910, deep woods on sand dunes; Illinois - sandy woods and in the open, along the shores of Lake Michigan, 1891; rich open woods Wilmington; dense growths on the flats of the Waupecan, near Morris, 4 to 5 feet high, 15 inches deep the rhizome, 1890-91. Missouri - 1893, common everyhere in the older parts of Stone County, rare in the woodlands; Warrensburg 1906.

Pteris caudata.

St. Cloud, Florida, 1930. Very common everywhere. Is the same plant mentioned and illustrated in the section "Ferns of Camptosorus".

Selaginella apus Spring.

On rocks close under Niagara Falls, Canada, 1890, kept constantly wet by the spray — under water at times.



much enlarged

Woodsia obtusa Torr.

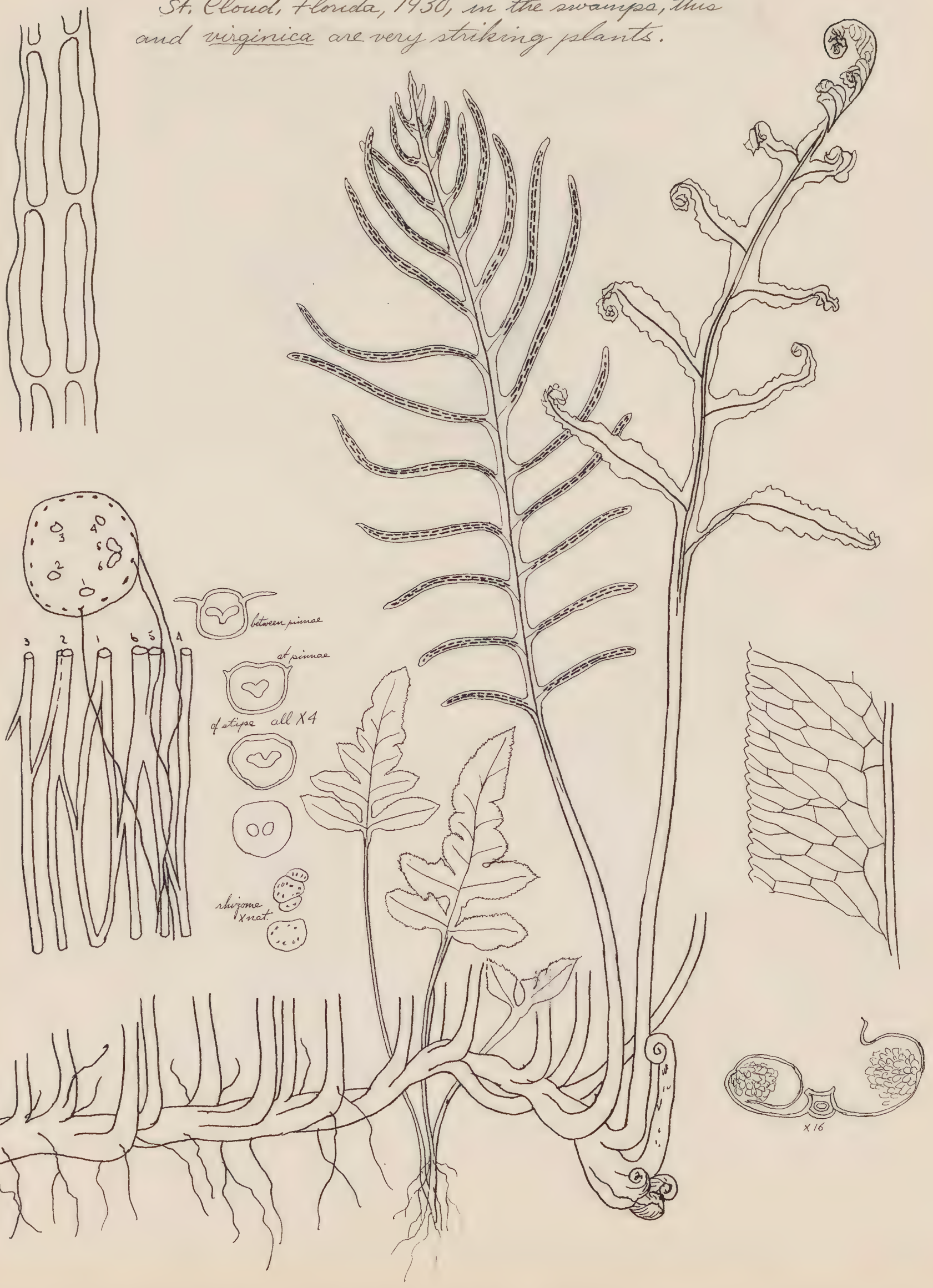
Missouri— One of the commonest ferns, Galena 1894, and Stone County; Warrensburg, sandy soil, 1902—; Turners 1912;

Woodsia oblusa ß *glandulosa* D.C.E.

Warrensburg, Mo. 1908.

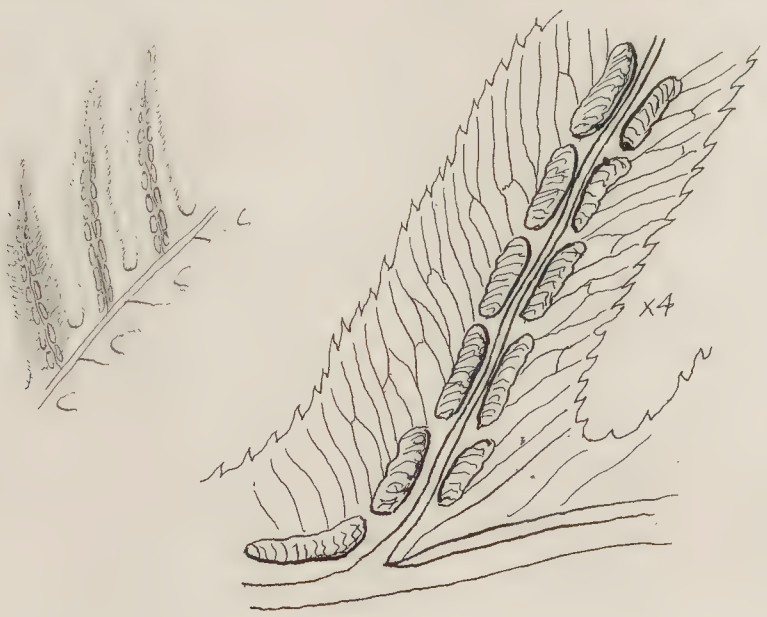
Woodwardia areolata

St. Cloud, Florida, 1930, in the swamps, this and virginica are very striking plants.



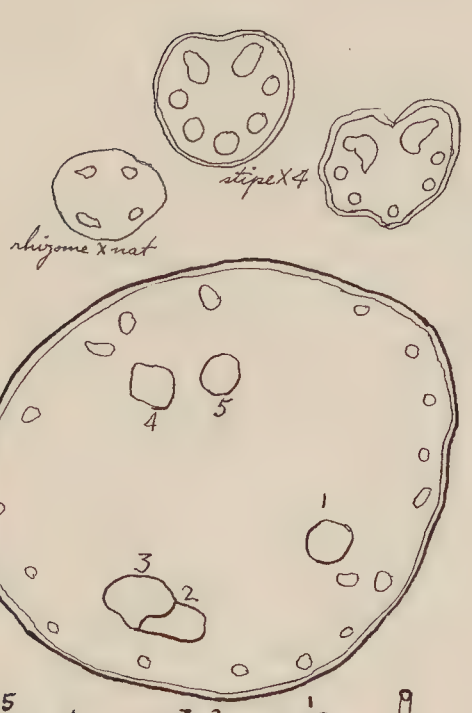
Woodwardia spinulosa f. ramosa A.A. Eaton

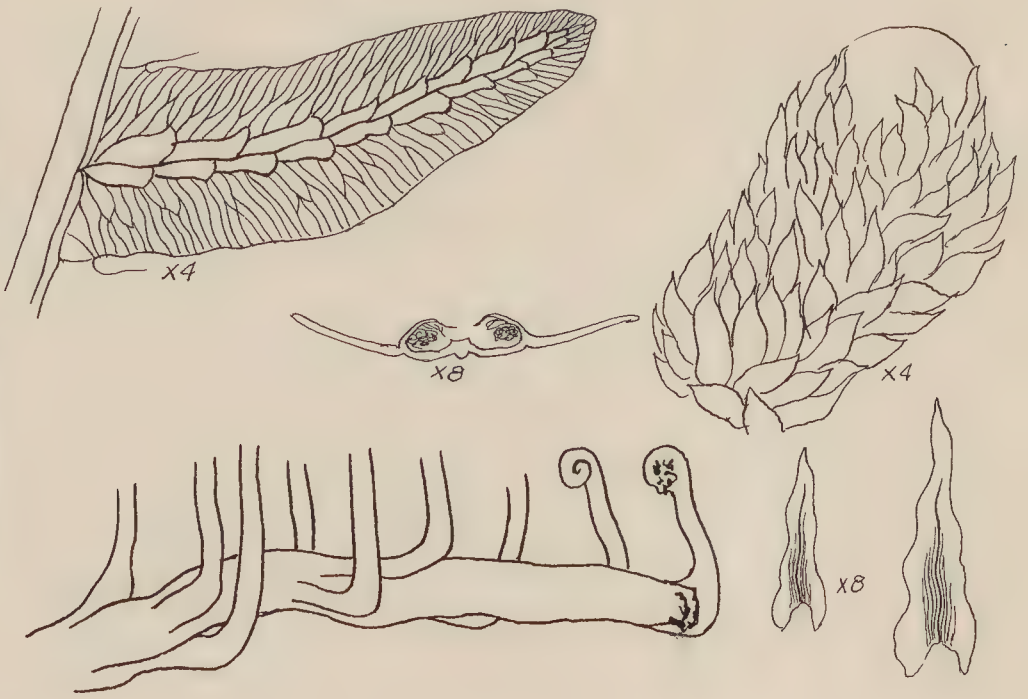
California – Santa Cruz Mts. 1902, — Yellowstone Park – Gibbons Meadows, 1902 – last week in August, plants froze hard every night, without apparent injury; Lake Washington, Puget Sound, 1902.



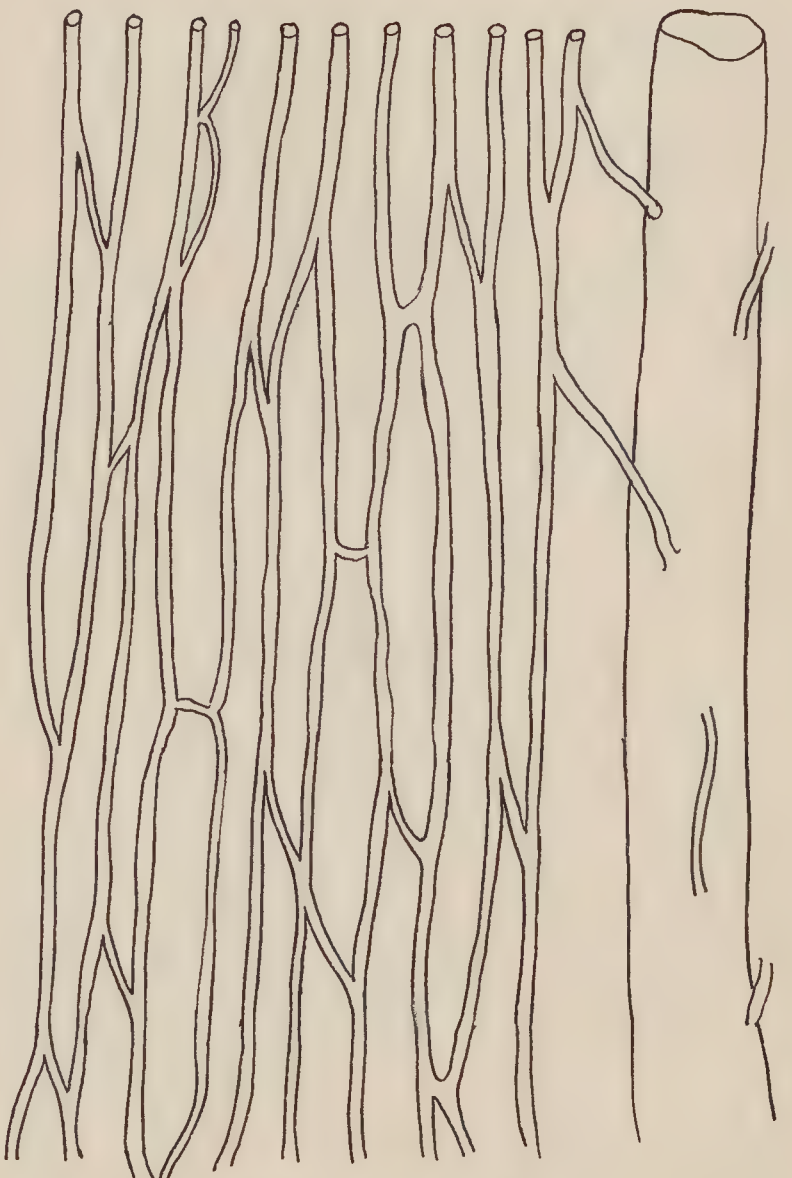
Woodwardia Virginica

St. Cloud, Florida, 1930, in the swamps and marshes, and in the drainage ditches.









Anastomosis of the small bundles

Part IV

Summary of the Results of Fifty Years Observation and Study of Some Common Ferns in Their Habitats - Mostly at "Camptosorus." —1885-1893-1928.

This "Summary" was inspired as an answer to the statements taught and published by botanists, who, evidently, have not had the opportunity of studying the ~~plants~~ ferns in their natural habitats, or who have unquestioningly copied from others.

In some cases, so carelessly (?) has the work been done that illustration and text (both borrowed) disagree widely from each other, and neither is correct!

Each statement of the "Summary" is based upon an intensive study over many years of the ferns themselves, not only those of the Ozarks, but of the same species from every part of the U.S.

It was a peculiarly fortunate circumstance that the major part of these studies could have been undertaken in that part of the Ozark hills lying in southern Stone County, Missouri, where every factor for the development of these ferns was present, without the extremes of weather, thereby favoring a perfectly natural longevity and growth.

And so I found that however feasible it is to describe the boundaries of life and behavior of a group of closely related forms it is utterly impossible to lay down hard and fast rules that will compass and apply to such a loose group of plants as is comprehended by the term, "Our Common Ferns," composed of plants of such widely differing habits.

There are many things which we must learn if we are to understand our ferns. This knowledge is best gained by studying the ferns themselves, and many individuals of the same species, undisturbed in their natural habitats.

This record of the results of many years of such study is made with the hope that it may prove helpful to others interested in fern study, and aid in correcting the many errors which has crept into fern literature.

Chicago, 1885-1893; Missouri 1893-1928.

Of their Growth. The fern is a slow grower. The best environment for its development is where moisture is ample and constant, and temperature moderate and uniform — never so cold, so hot, or so dry, as to kill it or its leaves, or otherwise seriously to check its growth. Even under the most favorable conditions its growth is slow.

It may be three years (Pteris aquilina) or ten years (Botrychium Virginianum) before the plant produces its first fertile frond and then it is far from being mature; it needs that much time to develop each succeeding frond.

After ten years Polypodium incanum still retained its primary leaf, and its leaves have not yet reached the size normal to the species. Forty-five years and the fronds of Onoclea sensibilis only faintly indicate their development in the direction of a trifoliate leaf. Thousands of years of fossil records show us that the occasional perfect tripinnate leaf of this fern is not a reversion but an anticipation of maturity.

Of their Seasons of Growth. The growth of the fern plant is continuous from the moment the oosphere is fertilized, and its "growing season," or that of any

of its parts, is not comparable with the season-habits of any other plant. Unlike most other plants, there is no "resting-phase," after the embryonic structure begins to form, and often absolutely none between the parents and the offspring. In some species, however, there seems to be a distinct resting stage between the ripening of the spore and the beginning of the new growth. This is only apparently so; the spore, as is common with many seeds, being only incompletely developed at the supposedly ripening time, and needing additional growth for maturity. There are ferns whose spores develops into young plants before they leave the sporangium

Some ferns may appear to have a season-habit because the alternation of their sterile and fertile fronds may seem to coincide with the seasonal growth habits of some other plants, but the ripening processes of the spores are not caused by season, and only affects the individual sporophyll.

When the leaves of a plant are killed by cold, and its growth, otherwise continuous, checked or retarded, it could not be called a seasonal habit of the plant!

<u>Of moisture.</u> The very beginning of a fern-plants' life is in a drop of water

In this fern country of Ozarkie, the Maiden-hair is not tempted to dwell where botanists try to limit her, "in high moist, shady woods," but will only grow when there is some flow or seepage from a spring; she prefers to have her feet in the water. So exacting is she in this particular, that there are few places where she can be found, and in those places she is beautiful.

Considering the comparatively small spread of root-surface of many ferns, ample moisture in the air would seem to be as necessary, if not more so, than in the earth. In fact, the roots of some act more like holdfasts than absorbing organs.

Observations were made for years on the response of Cheilanthes lanuginosa and Notholaena dealbata to air conditions. They grow normally in places much exposed to dry conditions. At night, and early in the morning when the air is heavy with dew, they unrolled their fronds, took on a fresher green and went on with growth. Polypodium incanum which, like them, had been rolled up tightly, looking dried up, dead, reacted in the same manner.

Most other ferns show similar response to moist air. Nephrolepis and other

ferns whose habitats are on the trunks or limbs of trees, or in holes in rocks must depend altogether upon atmospheric moisture. The fronds of Camptosorus and the rock aspleniums may become so dry and brittle as to easily be crushed to powder, but quickly resume their greenness and flexibility when the air becomes moist again.

Of the Soil. And what soil shall please my Lady best? A pile of limestone fragments, dark with weathering and age, with lichens and moss adhering, a sprinkling of rotting leaves, moisture all through and in the air, and the green shade of a thick woods suits most ferns. The thin layer of soil between a moist limestone ledge and the mats of lichen and moss that grow on it would be ideal for most — their rhizome in the moss, roots in the scant soil beneath — or an old, decayed log or stump in the dim, moist light of thick marshy woods, will sport a glory of the most beautiful delicately cut foliage ever seen.

Moist sand along the edge of some lake, marsh, or lazy stream, both in and out of the water for some. Others prefer a dryer footing; and grow in sandy woods soil.

It is strange how little they ask for

the amount they give, the great amount of beautiful leafy green. Many growing on trees where there is the least soil, and others seeming to seek the dryest, most exposed and soil-less hole they can find, disdaining mere soil altogether. Then, it seems as tho others could not get enough soil. Pteris has always worried the fern family with his notions and his burrowing habits. In the sand-dunes he explores widely and deeply. I suppose he always would, but he is lazy, too, and the soil must be loose, else else he remains close to the surface. In the hard packed stony soil of this vicinity he keeps pretty close to the top. The Botrychiums and Ophioglossums also have the deep earth habit, and pretty strongly too. The Equisetums, only dig in a little ways once a year.

The Chemical Reaction of the soil is supposed to be a great factor in determining the habitat of ferns. Many of them seem to prefer alkaline soils, or limestone. Some grow in soils with an acid reaction, while some seem to be totally indifferent to the matter.

It is certainly to be expected that the chemical quality of the soil would make a difference to those plants whose roots grew in direct contact with it- such as Pteris, Polystichum acrosti-

droides, Botrychium, Osmunda, and others, and the kind of rock might be a very important factor in determining the distribution of such ferns as Adiantum capillus-veneris which uses it for bread as well as board. What difference does mere soil make to Camptosorus, provided it has its bed of favorite mosses and lichens to grow in.

It was found that the plants themselves modified the soil considerably, so the tests were made of the soil immediately about the roots of the plants. A little distance away the soil gave quite different results. The larger and more mature the plants, and the more densely massed together the stronger the reaction. With Botrychium Virginianum there was a gradation in proportion to size of plant and depth of soil, those at the surface, of course being very young and small.

Chemical Reaction of Soils %

		acid	Alk.
Rensimmon Hollow	Botrychium Virginianum		50%
	Camptosorus rhizophyllus		70%
	Asplenium parvulum		"
	Asplenium ebeneum		"
	Polypodium incanum		"
	Adiantum pedatum		"
	Polystichum acrostichoides		"
Black Rocks (Jacques Creek)	Cheilanthes lanuginosa		60%
	Notholaena dealbata		"
	Pellaea atropurpurea		"
	Cystopteris fragilis		"
	Woodsia obtusa		"
	Camptosorus rhizophyllus		"
	Asplenium ebeneum		"
Thomas Spring Hollow	Pteris aquilina	10%	
	Pellaea atropurpurea	10%	
	Asplenium parvulum		10%
	Botrychium Virginianum	2%	
Roarke Hill	Ophioglossum Engelmanni		50%

		acid	Alk.
Jacques Creek	Woodsia obtusa		60%
	Cheilanthes lanuginosa		"
	Notholaena dealbata		"
	Pellaea atropurpurea		"
	Cystopteris fragilis		"
	Woodsia obtusa		"
	Camptosorus rhizophyllus		"
	Asplenium ebeneum		"
B. Hartley Hill	Ophioglossum Engelmanni		20%
	Pellea atropurpurea		50%
Lynch East Ravine	Adiantum pedatum		50%
	Polystichum acrostichoides		10%
	Asplenium ebeneum		4%
Iron Spring Hollow	Pellaea atropurpurea		50%
	Cystopteris fragilis		40%
	Camptosorus rhizophyllus		30%
	Woodsia obtusa		40%
	Adiantum capillus-veneris		70%

Rain - acid. Dew - acid.

Of the Green Light. Most ferns seem to thrive best in a greenish light — the light that is modified by passing through the green foliage of plants, such as in a woodland. There is a deeper meaning to this than the necessity for shade. In the hot-houses, as well as in natural conditions ferns grow more luxuriantly under other taller plants than they do in the white light; and even when not overtopped by other plants, they flourish better by being closely surrounded by green plants.

A rare tropical climbing fern had been growing luxuriantly for many years in a glass-house at a certain college. It began to bear fertile fronds, one of only three in captivity known to do so. The house was filled to nearly crowding with plants of all kinds, but was needed for experimental work. Everything was cleared out but this rare fern; gradually it declined, until in two years it was thrown out as worthless.

The face of a rocky bluff in Persimmon Hollow was covered with several species of fern. For a space the trees and shrubs intercepting the light, were cut away from the edge of the bluff. Gradually the ferns beneath died out. Nothing was altered but the green light. There remained ample shade. On either side, the ferns showed no change.

Of Reproduction – Sexual. The Gametophyte is an intermediary growth between the sexual and asexual phases of plant-life, which is developed from the spore, and so closely resembles a thallophyte, that it is often called the pro-thallus. It is minute, inconspicuous, green, and grows above ground. There are no roots, leaves, nor stems. There are exceptions to this in a few groups. In two of these it is without green color and grows underground, one of them sending a branch to the surface to supply the green; the other depending on some form of bacteria. In another group the gametophyte reaches an enormous size and performs most of the functions of the plant.

The gametophyte produces the sexual organs: from the union of the oosphere and the germ developed by them springs the asexual spore-bearing plant which is also green and above ground, but is conspicuous, and has roots, stems, and leaves.

The gametophyte may live a longtime after the young sporophyte has become self-sustaining, and may produce additional plants. It may produce branches which function in the same manner as the mother-gametophyte, or may become detached and become vegetative organs of reproduction.

When conditions are favorable, the primary root and leaf may exist indefinitely and may even participate in the growth and development of the plant.

Far down in Marvell Cave Glen, one the mossy ledges were hundreds of prothallia of Cystopteris and Woodsia, many of large size. Some were still attached to the sporophytes when the latter were two inches long and had several leaves. Some of these prothallia produced more than one sporophyte.

Some Onoclea sensibilis were grown from the spores; at three years old the prothallia of some was still attached and also the primary roots and leaves. It is not unusual for the prothallia to be long-lived.

The gametophytes and very young plants of Botrychium virginianum and Ophioglossum Engelmannii are very close to the surface in the loose humus, and grow deeper with age.

The development of spores, prothallia and young plants seems to progress far better in the green light, and on the vertical or very steeps sides of rocks, stream banks, etc. than on the level or horizontal surfaces, however more favorable the latter may seem to be.

Of Reproduction – Asexual reproduction is very common, especially in some groups. It may be by division, which is automatic, by the advancing of the dying zone, common to most ferns; by stolons-subterranean as in Ophioglossum Engelmannii and Nephrodium marginale; both aerial and subterranean as in Nephrolepis and Onoclea struthiopteris; bulbs on the roots of some Equisetums; bulbils on the fronds of Cystopteris bulbifera; buds on the extremities of the leaves of Camptosorus; and by layering as in the Equisetums. The prothallium also may function vegetatively, either itself, or by branches especially put out for the purpose.

Of the Stem or Rhizome Because the stems of most of our ferns are prostrate and are called rhizomes, does not necessarily mean that they are subterranean, or even submersed, tho in a few groups this is actually true. The rhizome grows indefinitely from an apical bud, and branches dichotomously, each branch also growing from an apical bud. Eventually the rhizome begins to die at the older end. As it advances it detaches the branches, which thus become separate plants. The progress of the dying zone is slower than that of the growing end. This is a general statement covering what really occurs. In some ferns the process is

far more complex, especially in those rapidly wide-spreading ferns such as Pteris. The advance of the dying zone would be far too slow to account for all the phenomena.

In Pteris caudata for instance, the rhizome puts out branches at quite regular intervals each side alternately. The first leaf of the branch is quite close to the main stem. On many of these branches a deep constriction is formed just beyond the first leaf. In time a sort of necrosis sets in which weakens, and eventually separates the branch at this point, forming independent plants while the main stem dying zone is still distant

The rhizome is not always horizontal. In some of our ferns it is ascending or erect; or creeping, or it may be climbing or trailing, and moving in any direction. The most horizontal are those that live among the lichens and mosses on the surface, and some of these, like our polypodiums refuse to grow in any set direction, and will leave the finest mossy bed on the level to climb the trunk of an adjacent tree. The Venus Hair often grows on the perpendicular face of a rock, and the rhizomes of many ferns ramble among loose rocks regardless of slope or direction. The rhizomes of Pteris roam ups and down as well as back and forth through the soil, and

rises towards the surface when about to emit a new branch – It always ducks again, however. Originating above ground, it is a puzzle why it should deliberately seek the deeper soil. The Equisetums have no true rhizomes, and each year make a new one out of one of their aerial ~~branches~~ stems. I cannot say whether or no it is decided by lot which one should "dig in," One goes and does it; curves down into the soil, puts out roots, puts up branches, and carries on the business without faltering.

The rhizomes of Botrychiums and Ophioglossums are thick and fleshy and perpendicular as to length. Some of our Aspidiae have inclined or upright rhizomes which often rise several inches above ground –

Of the Roots. The roots of ferns spring in acropetal succession from the leaf-bases, and grow from a single apical cell.* There is little or no tapering, remaining approximately the same width throughout their length tho in some plants; they may be very uneven. They branch dichotomously. The direction of their growth is usually strictly away from the point of origin so they and their branches often form a more or less dense mat about the rhizome. In other cases they grow horizontally, or curve downwards bending and twisting to attain these positions. In some ferns the roots are

from the pericambium just in front of a xylem ray and grow

* ~~Their origin, however, is from the outer cells of the libro-vascular bundles~~

more or less distant along the rhizome — in some becoming more numerous, often crowded, where a group of fronds arch clustered, and in others forming dense mats at such places, usually the young branches of the rhizome. Often the growing end is deeply imbedded in such a growth, the bud being entirely hidden. In others the growing end may be several inches in advance of any roots whatsoever.

The roots carry heavy growths of very fine hair roots either throughout their whole length, or in definite zones or areas.

In many ferns it is doubtful if the roots ever function save as holdfasts. Some plants grow in situations where the only available moisture is in the air. Extensive experiments have demonstrated that the roots have little to do with utilizing this moisture.

Like most of the characters possessed by the ferns, the differences shown by the roots may be used as means of identification.

<u>Of the Vernation</u>. The fern group is characterized by a circinnate vernation; — that is, their leaves are rolled up spirally in the bud. (like a watchspring). It does not

really matter that the bud seldom fulfills all the conditions of the term. The coil may not lie exactly in the plane of the axis, but it is a spiral coil, and that is all the term was meant to imply.

In fact, in most of the ferns, the coil is more or less diagonal to the midrib, and especially is this true of the pinnae. In most cases the term might more correctly be "helicoid," or "cochleate." While it is always inwards — towards the midribs, there appears to be two general methods in the coiling. In one, each segment is laid flat over the "ball" already formed, and in its turn is rolled in by the curve of the midrib. In the second case, each division is itself rolled up tightly "circinately," and laid against the coil either flatly, showing the side of its coil, or edgewise, showing its midrib.

And the outer members of the coil are protected by hairs or scales, which become a valuable means of identification.

In its <u>uncoiling</u>, no fern-leaf follows strictly the "watchspring rule." In general the movement begins in a truly circinate manner, then follows a straight line for a way, then becomes retrorse — curving backwards and downwards until the frond is nearly or

or quite unrolled, then the normal position of the part is gradually assumed. Owing to the influence of the many factors of its environment, such as light and shade, overcrowding, etc., it is not strange that seldom is the uncoiling true to type — often, no two fronds on the same plants uncoiling alike — yet, in general, so characteristic is it in some plants that the species may be recognized.

As a general rule, fronds produced in a compact group or rosette, grow with their faces toward the center,

Those that grow in open order always have their backs toward the growing point.

<u>Of the Fronds or leaves</u>. The primary leaf may live a long time and even increase in size, but this is unusual with our common ferns.

The leaves of ferns differ in many ways from the leaves of other plants. They rise from the stem in a regular spiral succession constant in the different groups. The spiral may be so "close" as to bring the fronds into a compact "crown," or it may be so "wide" that the leaves are so distant as to appear single or solitary. Their stems or stipes are continuous with the rhizome, and because of their place

in the spiral may have to curve or twist to bring the blades into proper relation to their environment. The rhizome itself may carry a twist which brings the leaf to an apparent line with the tops; or the vascular bundles may have a peculiar "broken-spiral" arrangement which also seems to line ups all the fronds on top of the rhizome.

The growth of the leaves, (and of each pinna) is continuous from an apical cell, and may go on indefinitely. That growth tends, mostly to cease when the leaf attains a size and development habitual to the species. In Nephrolepis, and Adiantum capillus-veneris the growth seems to be truly indefinite. In Camptosorus rhizophyllus it is confined to the fertile frond and is stopped ultimately by the development of a bud at the end, from which another plant arises.

Fern leaves are not deciduous. In but a very few are the stipes even obscurely articulated, so cannot be "shed." In several, the pinnae or pinnules are articulated, each to its own division of the rachis, and falls separately. This "shedding" is confined to the fertile fronds, and is connected solely with the ripening of the spores, and cannot be considered as "seasonal."

Every leaf of a fern is produced by the plant prepared and foreordained for the special functions it is to perform, which is determined at a very early period in its growth. It is not a matter of chance that a leaf should be fertile or sterile. All of our ferns produce leaves which are to be sporangiferous or fertile, and others which are to be vegetative or sterile. While there are many ferns whose fertile fronds possess a large vegetative surface, and may under some circumstances, bear sporangia in areas not usually occupied by them, no sterile frond ever has, or can be induced or forced to become fertile. If an apparently sterile frond should produce spores, it is simply a case where the function of a fertile frond was latent, and had revoked under the treatment.

It is ~~entirely~~ might be possible that the sterile portion of the fertile fronds of Botrychium virginianum ~~might~~ could be forced to bear sporangia by a system of denuding it of the fertile portion. Certainly no change could be made in the sterile fronds already formed in the bud. If the denudation were continued indefinitely, and the leaves appearing after the eleventh or twelfth showed the expected change it might be considered a definite response to the treatment.

As in all plant life there are variations and "sports," among the ferns. Some species seem particularly susceptible to hybridity as well.

In only a few ferns is the sporophyll smaller than the vegetative frond, altho the latter often equals the former. Usually the fertile frond is the larger and most conspicuous, and the most highly developed toward the type. The sporangia may appear on any part of its surface but are usually confined to definite portions of it, the place, and character being so constant that the recognition of the group is based upon it. So much so that if the fertile frond of Botrychium virginianum were to bear sporangia on what is now its sterile lamina, it would no longer be vir-giniianum!

The sterile fronds are much longer lived than the fertile; and where the sporangiferous portion of the fertile frond is comparatively smaller than the vegetative portion, it is proportionately longer-lived. Where the whole frond is sporangiferous, its life endures only to the ripening of the spores.

The sterile fronds may persist a long time after growth in size has ceased, performing their vegetative functions, and may live

for many years.

The order or succession in which the sterile and fertile leaves are produced is strictly according to a fixed plan for each species, subject to certain conditions. Thus, some species, as Marsilia and Stenochlaena may produce nothing but sterile fronds for years, while conditions are best for their vegetative growth; then, when drouth or other bad conditions threaten they become phenomenally fruitful. But always, the sterile frond precedes the fertile. Where the fertile fronds seem to come first, the succession count may be wrong; or, as with the Osmunda cinnamomea, the sterile fronds grow so much slower, and it will be found that the fertile fronds rise from the younger part of the stem.

Now the sterile fronds may appear one year, the fertiles following early the next; or the steriles may appear continuously with a single or occasional fertile; they may appear alternately through the year. But the main succession, and the only recognition of season, is of groups of steriles during the cool moist part of the year, groups of fertiles when the hot season approaches.

Sports, etc. Most ferns produce their fronds partially formed, their development being continued by the apical cells of the frond and its divisions while unrolling and expanding. During this period they may be modified to a considerable extent by the factors of their environment

Such differences occur to the growing parts and are not known to be heritable.

Clover plants may bear leaves with four or more leaflets, but all attempts to perpetuate the habit have failed.

The variations from the normal in the fronds of Onoclea sensibilis, is spoken of by some botanists a a "reversion;" a million years of fossils dis proves this. It might mean a plinophery.

The forced results secured by experimentors are mistakenly ascribed to fundamental, instead of superficial conditions.

A man may set a record of speed when chased by a peril, and yet not be classed as an athlete.

Spanish

It must be understood that all plants do not recognize the arbitrary succession of "seasons" as man has laid them out, the actual "resting stage" for many being in mid-summer — the new growth beginning in the Fall.

As with other plants, the fruiting period of ferns follows the vegetative, midsummer being the ripening time for most, the cooler part of the year being devoted to vegetative growth.

In the case of the Cinnamon Fern, and a few others, so closely does the new growth follow the fruiting, that it has been used to prove (?) the theory of the precedence of the fruiting fronds.

Resistance to Cold. Some ferns are exceedingly sensitive to cold and frost. Onoclea sensibilis leading in that respect, but only the leaves suffering. Cystopteris fragilis, Cystopteris bulbifera, Adiantum pedatum, Woodsia obtusa, following in the order named. ~~Aspidium~~ ~~Nephrodium~~ Polystichum acrostichoides is notoriously evergreen; and altho Onoclea's sterile fronds may die at the first touch of frost, its fertile fronds continue green and growing all winter, ripening the spores the following summer.

The Chain-fern in Yellowstone Park, froze so hard over night in August, that, at 8 o'clock in the morning they would shatter to pieces if struck roughly — yet at noon they had thawed out, and were apparently none the worse! In Florida they are considered delicate. (is this the same fern?

Part V. Ferns of the United States and Canada acquired for comparative study - 1887 — 1928.

Adiantum capillis-veneris L.

1903 Louisiana New Orleans Metcalf
1909 Florida . . . . . Noble
1911 California Mt. Wilson trail Morley

Adiantum tenerum Swz.

1918 Cuba . . . . . H J Limric

Adiantum emarginatum Hook.

1909 California San Miguel Kimball
1909 Calif. Los Buellos Hills R J Smith
1909 Calif. Mt. Davy - - - R J Smith

Adiantum pedatum L.

1909 New Hampshire Hinsdale Metcalf
Alaska, Katchekan, LaRue
Excursion Inlet LaRue
Missouri Cass Co. - - - - Gearheart
Lamont - - - - Staples
1910 Maine Gorham - - Fellows
1905 Ft. Kent Fellows
Wisconsin Kilbourne Marshall
Appleton - - Marshall
1911 Calif. Mt. Wilson - - Morley
1909 Michigan Burt Lake - Smith
Missouri Lamont Staples

Aneimia adiantifolia Swz.

1918 Cuba H J Limric

Aspidium falcatum Swz.

1905 Florida - - - - - - Noble

Aspidium trifoliatum Swz.

1914 Cuba - - - - - - - H J Limric

Asplenium pinnatifidum Nutt.

1907 Penna. Keurs Jerglen Poyser
1917 Alabama Jackson Co. Graves

Asplenium ebeneum Ait.

1904 N. Hamp. Hinsdale Metcalf

Asplenium trichomanes L.

1904 Wisconsin Kilbourne Marshall
N. Hamp. Hinsdale Metcalf
1905 Missouri Columbia Walters
1914 Ohio - - - Portage Co. Hopkins

Asplenium vespertinum Maxon

1900 Calif. San Miguel Mt. Kimball

Asplenium viride Huds.

1917 Ontario Owen Sound McColl

Asplenium septentrionale (L.)

1903 Colorado Cheyenne Mt. Schantz

Asplenium angustifolium Michx.

1903 Vermont Brattleboro Metcalf
1908 Missouri Henry Co. Gearheart

Asplenium ruta-muraria L.

1904 Ohio - - yellow Spgs. Hopkins

Asplenium montanum Willd.

1904 Penna. Allegheny Mts. Hatry
1914 Georgia Tallulah Falls Benedict

Asplenium Bradleyi D.C.E.

1914 Georgia Stone Mt. Benedict
1917 Georgia Wade Co. Graves

Athyrium filix-femina (L.)

1903 New Hamps. Hinsdale Metcalf
1904 Wisconsin Kilbourne Marshall
1909 Alaska Excursion Inlet LaRue
1910 Michigan Macatawa Smith
1908 Ohio Portage Co. Hopkins
1914 Ohio Portage Co. Hopkins

Athyrium filix-femina angustum Willd.

1912 Idaho Bitter Root Valley Smith

Athyrium thelypteroides (Michx.) Desvt.

1904 Wisconsin Kilbourne Marshall
1912 Ohio Summit Co. Hopkins

Athyrium thelypteroides serratum Lawson

1915 Ohio Summit to. Hopkins

Blechnum serrulatum Richard

1906 Florida Lake Helen Noble

Blechnum occidentale

1907 Mexico - - - - - - - Hoover

Botrychium biternatum (Lam.) Underw.

1918 Alabama Spring Hill Graves

Botrychium lanceolatum (Gmel.)

1905 Vermont Dorset Bourne
1912 Michigan Burt Lake Smith

Botrychium lunaria Onondagense Underw.

1916 New York Jamesville Ranger

Botrychium matricariaefolium Al. Br.

1905 Vermont Dorset Bourne
1912 Michigan Burt Lake Smith

Botrychium simplex Hitch.

1908 Vermont Dorset Bourne

Botrychium ternatum obl. alabamense (Maxon)

1918 Alabama Mobile Co. Graves

Botrychium ternatum obl. dissectum Spreng.

1903 Maine S. Chesterfield L.O Eaton
1904 Vermont Dorset Bourne
1913 Michigan Macatawa Smith

Botrychium ter. obl. elongatum Gilb. & Hab.

1912 Michigan Black Lake Smith

Botrychium ter. obl. intermedium D.C.E.

1905 Vermont Dorset Bourne
1912 Michigan Macatawa Smith
1913 - - - - - Douglas L. Smith
- - - - - - - Black Lake Smith

Botrychium ter. obl. vulgare

1913 Michigan Douglas L. Smith

Botrychium Virginianum (L.)

1902 N. Hampshire Hinsdale Metcalf
1904 Wisconsin Kilbourne Marshall
1913 Michigan Douglas L. Smith
1913 Missouri Cass Co. Gearheart

Botrychium Virginianum gracile Pursh

1909 Missouri Lamont Staples
1912 Michigan Douglas L. Smith

Cryptogramme acrostichoides R.Br.
1904 Washington Cascade Mts Flett
1912 Idaho - - - - - - - Smith

Camptosorus rhizophyllus (L) Link
1904 Wisconsin Blue Mounds Marshall
1904 Vermont Brattleboro Metcalf
1909 Missouri Lamont Staples
1912 Ohio Green Co. Hopkins

Cheilanthes alabamensis (Buckl.) Kunze
1917 Alabama Sheffield Graves

Cheilanthes California (Mett)
1904 California San Miguel Mts Kimball

Cheilanthes Clevelandii D.C.E.
1904 California San Miguel Mts. Kimball

Cheilanthes Fendleri Hook
1900 Colorado Cheyenne Mts Schantz
1904 California Mt. Lowe Marshall

Cheilanthes lanuginosa Nutt.
1905 Missouri Columbia - Walters

Cheilanthes Lindheimeri Hook
1904 Texas - House Mtn. Reverchon

Cheilanthis tomentosa Link
1914 Georgia Stone Mtn. Benedict

Cheilanthes vestita Swz
1907 New Jersey Milford Poyser

Cystopteris bulbifera (L) Bernh.
1903 Vermont Brattleboro Metcalf
1904 Wisconsin Kilbourne Marshall
1908 Ohio - - Greene Co. Hopkins
1911 Michigan Douglas L. Smith

Cystopteris fragilis (L) Bernh.
1908 Missouri Belmont Staples
1903 N. Hampshire Hinsdale ~~Hopkins~~ Metcalf
1910 Ohio Mahoning Co. Hopkins
1911 Michigan Douglas L. Smith
1912 Oklahoma Sulphur Dunthitt
1913 Michigan Burt Smith
1913 Colorado Boulder Ashley
1914 California Mt. Wilson Morley
1914 Ohio Summit Co. Hopkins

Cystopteris fragilis dentata Hook.
1905 Wisconsin Kilbourne Marshall

Cystopteris fragilis laciniata Dav.
1904 Wisconsin Kilbourne Marshall
1908 Missouri Cass Co. Searheart

Cystopteris montana Bernh.
1900 Alaska Nome City Flett

Dicksonia Antaactica
1904 Australia - - - - Metcalf

Dicksonia punctilobula (Michx.)
1903 N. Hampshire Hinsdale Metcalf
1912 Canada Ayers Cliff Lynch
1913 Ohio - - - Summit Co. Hopkins

Equisetum hiemale affini (Engel.)
1907 Ohio Geauga Co. Hopkins

Equisetum hiemale intermedia A.A. Eaton
1910 Ohio - - - Wayne Co. Hopkins

Equisetum laevigatum A. Br.
1908 Ohio Clark Co. Hopkins
1910 Michigan Macatawa Smith
1915 Missouri Courtney Bush

Equisetum laevigatum ramosum A.A. Eaton
1915 Missouri Courtenay Bush

Equisetum littorale Kuhn
1912 Penna - Allegheny Co Hopkins

Equisetum robustum
- - - California Santa Clara Co J.P. Smith

Equisetum robustum ramosum
1912 Ohio Portage Co Hopkins

Equisetum sylvaticum L
1913 Ohio Geauga Co. Hopkins

Gymnogramme calomelanos (Kunze)
1914 Cuba - - - - H.J. Linric

Gymnogramme triangularis Kaulf.
1901 Washington Eatonville Flett
1901 California Los Angeles Co. Moxley
1904 - - - - - San Miguel Mt. Kimball
1904 - - - - - Spring Valley Kimball
1894 - - - - - San Bernardino Eaton

Gymnogramme triangularis viscosa N.C.E.
1904 California San Diego Kimball

Hymenophyllum recurvum Gand.
1899 Hawaii Oahu Honolulu Kimball

Isoetes Butleri Engelm.
1915 Missouri Noell Bush

Isoetes echinospora Braunii Engelm.
1913 Ohio Portage Co. Hopkins

Lycopodium complanatum flabelliformum
1914 Ohio Portage Co. Hopkins

Lycopodium obscurum dendroideum
1914 Ohio Portage Co Hopkins

Lygodium japonicum Swz.
1904 Georgia Thomasville Metcalf

Lygodium palmatum (Bernh.) Swz.
1899 New Jersey Medford Metcalf
1903 New Hampshire Wichester Metcalf

Nephrodium Clintonianum (Mich.) Dowell
1912 New York Sawerwoods Dowell
1913 Michigan Douglas L. Smith
1916 Connecticut Plainville Bigelow

Nephrodium Clint. X intermedium Dowell
1916 Connect. Plainville Dowell Bigelow

Nephrodium Clint. X marginale Gibson
1916 Conn. Plainville Bigelow

Nephrodium Clint. X spinulosum Benedict
1908 Wisconsin Kilbourne Marshall
1916 Connect. S. Windsor Bigelow

Nephrodium cristatum (L) Michx.
1902 Penna. Pittsburg Halsey
1904 Maine S. Chesterville L.O. Eaton
1904 N. Hampshire Hinsdale Metcalf
1912 Michigan Douglas L. Smith
1912 Mich. Fishtail L. Smith
1914 Ohio Portage Co. Hopkins
1916 Connect. S. Windsor Bigelow

Nephrodium crist. X intermedium Dowell
1914 Ohio Kent Hopkins
1916 Connect. S. Windsor Bigelow

Nephrodium crist. X marginale Dav.
1905 Connect. Granby Holcomb
1916 Connect. Plainville Bigelow

Nephrodium crist. X spinulosum (Michx.) Christ.
1903 Connect. Granby Hopkins
1914 Ohio Portage Co. Hopkins
1916 Vermont Westmore Bigelow
1917 Ohio Kent Hopkins

Nephrodium filix-mas (L) Richard
1912 Vermont Barnard Rugg
1916 Vermont Northfield Bigelow

Nephrodium filix-mas X marginalis Winslow
1916 Vermont Northfield Bigelow

Nephrodium fragrans (L) H & B
1890 Florida - - - - - Halsey
1904 Alaska Nome City Flett
1906 Maine - Cascade Brook Falls Fellows

Nephrodium Goldianum (Hook)
1911 Michigan Macatawa Smith
1912 Ohio Geauga Co. Hopkins
1916 Connect. Plainville Bigelow
Nephrodium Gold. X marginale Dowell
1916 New York Jamesville Bigelow
Nephrodium intermedium (Carr) Baker
1902 Penna. Pittsburg Hatry
1903 N. Hampshire Hinsdale metcalf
1905 Wisconsin Kilbourne Marshall
1913 Michigan Burt Lake Smith
1916 Connect. Avon - Bigelow
Nephrodium int. X marginale Benedict
1916 New York Springville Bigelow
Nephrodium marginale (L.) Michx.
1904 New Hamps. Hinsdale metcalf
1904 Wisconsin Kilbourne Marshall
1916 Connect. Avon Weatherby
Nephrodium marginale X spinulosum Clausen
1916 New York Pt. Richmond Bigelow
Nephrodium molle D. esv.
1918 Alabama Mobile Co. Graves
Nephrodium noveboracense (L.) D. esv.
1903 N. Hamps. Hinsdale Metcalf
1910 Michigan Macatawa Smith
1912 Canada Quebec Lynch
1914 Ohio Portage Co. Hopkins
Nephrodium patens (Sw.) D. esv.
1904 Mexico ——— Kimball
1914 Cuba ——— H.J. Limrick
1918 Alabama Mobile Co. Graves
Nephrodium rigidum-argentum (Kaulf.) Davenport
1904 Calif. San Miguel Mt. Kimball
1909 Calif. Los Angeles Co. Morley
1913 Calif. Los Angeles Co. Morley
Nephrodium simulatum Davenport
(noveboracense X thelypteris)
1903 New Hamp. Hinsdale metcalf
Nephrodium spinulosum (Muell.)
1900 Penna. Alleghany Co Hopkins
1903 Penna. Pittsburg Hatry
1904 Wisconsin Kilbourne Marshall
1909 Alaska Excursion Inlet La Rue
1912 Canada Quebec Lynch
1916 Connect. S. Windsor Weatherby
Nephrodium spin. dilatatum (Hoffm.).
1903 Pennsylv. Pittsburg Hatry
Nephrodium thelypteris (L.) D. esv.
1904 N. Hamp. Hinsdale metcalf
1904 Wisconsin Briggsville Marshall
1905 Maine S. Harpswell Van Cleave
1913 Michigan Burt Lake Smith
1913 Ohio Kent Hopkins
Notholaena cretacea Liebm.
1904 California Spring Valley Kimball
Notholaena dealbata Kunz
1915 Missouri Swope Park, Kansas City Bush
Notholaena Fendleri Kunz
1900 Colorado Cheyenne Mt. Schantz
Notholaena Newberryi D.C.E.
1900 California San Miguel Mt. Kimball
Onoclea sensibilis L.
1904 N. Hampsh. Hinsdale metcalf
1905 Maine S. Harpswell Van Cleave
1912 Michigan Burt Lake Smith
Onoclea sensibilis obtusilobata Torrey
1909 Wisconsin Monticello Marshall
Ophioglossum Californicum Prantl
1904 California San Diego Kimball
Ophioglossum vulgatum L.
1884 N. Hampshire Kensington Eaton
1910 Connecticut Granby Holcomb
1911 Maine S. Harpswell Van Cleave
1922 Texas - - - - Rude
Ornithopteris adiantifolia Bernh.
1914 Cuba - - - - H.J. Limrick

Osmunda cinnamomea L.
1902 Penna. Pittsburg Hatry
1903 N. Hampsh. Hinsdale Metcalf
1904 Wisconsin Kilbourne Marshall
1913 Michigan Douglas L. Smith
Osmunda claytoniana L.
1904 Wisconsin Kilbourn Marshall
1904 N. Hampsh. Hinsdale Metcalf
1912 Michigan Douglas L. Smith
1914 Ohio Portage Co. Hopkins
Osmunda regalis L.
1904 N. Hampsh. Hinsdale Metcalf
1904 Wisconsin Kilbourn Marshall
1912 Wisconsin Dallas Marshall
Pellaea androvedaefolia (Kaulf.) Fee
1893 California Horns Peak Eaton
1904 California - - Kimball
1904 California San Diego Metcalf
1908 California Mt. Day R.J. Smith
Pellaea atropurpurea Link
1900 Vermont Winooski Fellows
1904 Wisconsin Kilbourn Marshall
1908 Ohio Clark Co. Hopkins
1912 Oklahoma Sulphur Boothill
Pellaea brachyptera (Kunze) Baker
1905 Florida - - - - Hatry
1906 California Mt. Lowe Marshall
Pellaea Bridgesii (Hook)
1908 California Santa Clara Valley R.J. Smith
Pellae densa Hook.
1905 Washington Mt. Adams Flett
1905 California Yosemite Valley R.J. Smith
1911 Montana McArthur Smith
Pellaea glabella Mett. & Kuhn
1918 Canada Owen Sound McColl
Pellaea gracilis Hook
1906 New York Manlius Ransier
1918 Canada Owen Sound McColl
Pellaea ornithopus Hook
1911 California Los Angeles Co. Morley
Phegopteris dryopteris (L.) Fee
1904 Wisconsin Kilbourne Marshall
1904 N. Hampshire Hinsdale metcalf
1910 Ohio Mahoning Co. Hopkins
1910 Michigan Macatawa Smith
1911 - - - Douglas L. - - -
1912 - - - - - - - - - - - -
1913 - - - - - - - - - - - -
Phegopteris hexagonoptera (Michx.) Fee
1904 N. Hampsh. Hinsdale metcalf
1905 Wisconsin Appleton Marshall
1908 Ohio Wayne Co. Hopkins
1914 Ohio Kent Co. Hopkins
Phegopteris polypodioides Fee
1900 Alaska - - - - - Flett
1904 Switzerland Lauterbach Metcalf
1904 Wisconsin Kilbourn Marshall
1903 N. Hampsh. Hinsdale metcalf
1909 Alaska Excursion Inlet La Rue
1912 Canada Quebec Lynch
1912 Michigan Douglas L. Smith
1912 Ohio Portage Co. Hopkins
Phegopteris Robertiana
1909 Alaska Excursion Inlet La Rue
1918 Canada Owen sound McColl.
Polypodium aureum L.
1904 California - - - - - Kimball
Polypodium Californicum Kaulf.
1894 California San Bernardino Metcalf
1904 California Mission Valley Kimball
1911 California Los Angeles Co. Morley
1914 California S. Barbara Mts. R.J. Smith
Polypodium deflexum Kaulf.
1907 Mexico - - - - - - - - Hoover
Polypodium incanum Sw.
1904 Alabama Mobile Metcalf
1905 Florida New Smyrna Noble
1914 Georgia Stone Mtn. Benedict

Polypodium falcatum Kellogg
1904 Washington Tacoma Flett
1909 Alaska Excursion Inlet LaRue
Polypodium hesperium Maxon
1904 Washington Cascade Mts. Flett
1911 Idaho 22000 Smith
Polypodium vulgare L.
1905 Wisconsin Kilbourn marshall
1904 N. Hampsh. Hinsdale metcalf
1905 maine S. Harpswell VanCleave
1909 Alaska Excursion Inlet LaRue
1912 Ohio Wayne Co. Hopkins
1912 Ohio Geauga Co Hopkins
1913 Michigan Douglas L. Smith
Polystichum acrostichoides (Michx) Schott
1902 N. Hampsh. Hinsdale metcalf
1907 Missouri Lamont Stapleton
1908 Ohio Wayne Co. Hopkins
1910 Michigan Macatawa Smith
Polystichum aculeatum Braunii (Spencer)
1898 Canada Montreal Hatry (Lawson
1906 Maine New Canada Plantation Fellows
Polystichum lonchitis (L) Roth
1892 Montana Billings Hatry
1903 Washington Cascade Mts. Flett
1918 Canada Owen Sound McCall
Polystichum munitum (Kaulf) Presl
1913 California Mt. Wilson Moxley
Pteris aquilina L.
1900 Colorado Cheyenne Mt. Schantz
1903 N. Hampsh. Hinsdale Metcalf
1904 Wisconsin Kilbourne Marshall
1912 Ohio Portage Co. Hopkins
1913 California Mt. Wilson Moxley
Pteris Cretica L
1901 Alabama - - - - - - Hatry
Pteris Cretica albo-lineata
1901 Alabama - - - - - - Hatry
Pteris longifolia L
1903 Cuba - - - - - - - - H Shimic
1903 Florida - - - - - - - Hatry
1905 Louisiana N. Orleans Hatry
Pteris serrulata L. fils.
1904 Alabama Mobile Co. Metcalf
Schizaea pusilla Pursh.
1907 N. Jersey Egg Harbor Pepper
Scolopendrium vulgare J E Smith
1918 Canada Owen Sound McCall
1903 New York - - - Hatry
Selaginella apus (L) Spreng.
1913 N. Hampsh. Hanover Rugg
1914 Georgia Tallulah Falls Benedict
Selaginella cinerascens A A Eaton
1904 California National City Kimball
Selaginella rupestris densa (Rydb.)
1903 Colorado Ute Pass Schantz
Selaginella rupestris Fendleri Hieron.
1900 Colorado Cheyenne Mts Schantz
Struthiopteris germanica Willd.
1910 Michigan Macatawa Smith
Trichomanes Petersii A. Gray
1916 Alabama Marshall Co Graves
Vittari lineata (L) J E Smith
1903 Florida New Smyrna Hatry
1909 Florida Hummocks Metcalf
Woodsia glabella R. Br.,
1900 Alaska Nome City Flett
Woodsia ilvensis (L) R. Br.
1900 Alaska nome city Flett
1904 Wisconsin Kilbourne Marshall
Woodsia scopulina D C E
1901 Washington Cascade Mts Flett
Woodsia obtusa Torr.
1902 Penna - Pittsburg Hatry
1904 Indiana Clark Co. Kimball
1908 Oklahoma Ohio River bluffs Bartlett
1908 Ohio Sulphur Grove Co. Hopkins

Woodwardia angustifolia J E Smith
1909 Florida L. Helen Hatry
Woodwardia spinulosa Mart. & Gale.
1910 California Los Angeles Co Blake
1911 California Los Angeles Co Moxley
Woodwardia Virginica J E Smith
1912 Ohio Kent Hopkins
1912 Ohio Portage Co. Hopkins

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Mt. Lowe - Cali.



Selaginella Bigelovii

Calif.



Aspidium spinulosum,
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Ophioglossum
californicum

calif.

Asplenium vespertinum.
Mt. Lowe, Calif.



Polypodium hesperium
Washington

Polypodium vulgare,
Wis.



Aspidium patens
Calif.



Woodsia glabella
Cape Nome
Alaska

Cheilanthes californica
Calif.



Pelleae andromedaefolia.
Calif.



Asplenium montanum
Penn.



Asplenium trichomanes
The 'Ozarks'
Missouri.



Cryptogramme
acrostichoides
Wash.



Notholaena
Cretacea,
Calif.



Notholaena
Newberryi
Calif.



Cheilanthes lanuginosa
Columbia,
Mo.



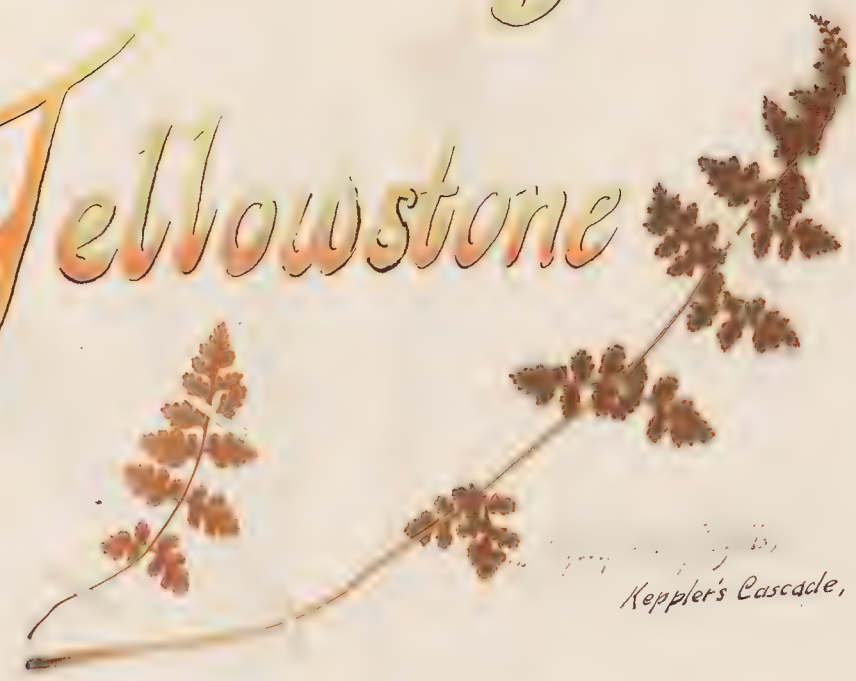
Gymnogramme
triangularis

Santa Cruz Mts.
Calif.



Cheilanthes Clevelandii
San Miguel,
Calif.

Souvenirs of Yellowstone



Keppler's Cascade,



Narcbell

Willow Park



Painted Cup

Phlox

Gibbon Meadows



Yellowstone Daisy

Hayden Valley -



Blue Gentians -

Gibbon Meadows.



Fire-Hole River.



Natural Bridge

Golden Rod

Fire Hole River

Yarrow

Gibbon Meadows,



Natural Bridge.



Hayden Valley



Willow Park -